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AT HARVARD COLLEGE.

Vol. XLVII.

NEMERTEANS OF THE WEST AND NORTHWEST COASTS OF AMERICA.

By Wesley R. Coe.

With Twenty-five Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

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CONTENTS.

Introduction.

The present article includes the results of a study of a vast amount of material which has been placed in my hands from a number of different sources. It is, however, based primarily upon the collections contained in the Museum of Comparative Zoölogy, Harvard College. Through the generosity of Mr. Alexander

Agassiz I have been given permission to incorporate in this report the results of a study of material brought together from some sixteen distinct collections.

This material was collected over a wide range of territory, including the whole extent of the Pacific coast of North America from Panama to the Aleutian Islands, northward through the Bering Straits far up into the Arctic Ocean, and westward to the Commander Islands off the coast of Kamchatka. It includes both shore collections and dredgings off the coast to a depth of several hundred fathoms.

The following collections comprise the bulk of this material: —

1. A small collection from Panama and the coast of California, made many years ago by Mr. Alexander Agassiz, and now the property of the Museum of Comparative Zoölogy, Harvard College.

2. A small collection belonging to the Peabody Museum, Yale University, made by Mr. F. H. Bradley at Panama.

3. Very extensive collections made by the U. S. Fish Commission Steamer Albatross along the whole west coast of North America during the years 1888 to 1895. These collections include a few forms collected on shore at low water, although the great bulk of the material was dredged at various localities off the coast at depths ranging from a few to several hundred fathoms. The greatest depth at which nemerteans were collected was 414 fathoms, the greater number being taken in less than 60 fathoms. Several very interesting forms presenting anatomical peculiarities adapted for life at considerable depths of water are included in these collections, and are described on the following pages. A single species of pelagic nemertean (*Planktonemertes agassizii* Woodworth) was taken at the surface in the equatorial regions. An individual of another species (*Euborlasia maxima*) measures 45 mm. in width after preservation, and probably exceeds in bulk any other known species.

4. Collections made in 1882 by the Point Barrow Relief Expedition to Northern Alaska and the Arctic Ocean.

5. Collections, drawings, and notes made by Mr. B. B. Griffin in Puget Sound and Southern Alaska, while a member of the Columbia University expeditions in 1896 and 1897. The death of this enthusiastic young investigator occurred while engaged in the study of these specimens. A preliminary report (Griffin, '98) con-

taining brief descriptions of 12 of the species recorded in the following pages was published subsequent to his death. A list of these forms is given on p. 85–86. Several of the colored drawings made by Mr. Griffin are published in the present paper, while his notes, microscopic sections, and collections have been of much service in the preparation of this report.

6. Collections made by Dr. W. H. Dall during several years spent in explorations on the coast of Alaska.

7. A small collection made by Mr. Creswell Shearer of McGill University, at Vancouver Island, B. C.

8. A collection of about twelve species from Pacific Grove, Cal., accompanied by very careful and detailed notes and sketches made by Prof. C. B. Wilson, of Westfield, Mass. These notes are freely incorporated in the descriptions on the following pages, and have added much to the completeness of this report.

9. A number of carefully made drawings (some of which are colored) of nemerteans from Pacific Grove, Cal., and many valuable notes on distribution, have been generously placed in my hands by Mr. J. F. Abbott of St. Louis, Mo. Several of these drawings are published herewith, acknowledgments being made in the explanations of plates.

10. Collections made by Professors Ritter and Kofoid, in connection with the Biological Survey of the University of California off the coast of Southern California during the summer of 1901.

11. Collections made by various correspondents of the U. S. National Museum, including those of Dr. L. Stejneger on the Commander Islands, of Capt. M. A. Healy of the U. S. S. *Corwin*, of Mr. Wm. Palmer and of Mr. W. H. Jones, all of whom collected nemerteans on the coast of Alaska.

12. Collections made by myself at various localities along the whole Pacific coast of Alaska from British Columbia to the Aleutian Islands, while a member of the Harriman Alaska Expedition in 1899, as well as all the nemerteans collected on the same expedition by Prof. W. E. Ritter of the University of California, and Prof. Trevor Kincaid of the University of Washington.

13. Collections which I have also made personally on the coast of California while enjoying the hospitality of the University of California Biological Station at San Pedro, and of the Hopkins Seaside Laboratory of Stanford University at Pacific Grove, during the summer of 1901.

14. A small collection, accompanied with notes on coloration, made by Mr. A. J. Carlson of Stanford University at Pacific Grove, Cal.

15. Several specimens collected in Puget Sound by Prof. Trevor Kincaid of the University of Washington.

16. Since this report was first completed, in June, 1903, I have received the collection of nemerteans made by the U. S. Fish Commission Steamer Albatross in connection with the Alaska salmon investigations of 1903. The data obtained from a study of this collection are now incorporated in the present report.

It should be added that the above include all the nemerteans from the West Coast of North America contained in the U. S. National Museum. These, together with Mr. Griffin's collections, were first placed in the hands of Dr. W. McM. Woodworth of the Museum of Comparative Zoölogy, Harvard College, and by him were turned over to me.

The type specimens of many of the species described below are from my personal collections and are to be deposited in the Yale Museum. Cotypes of most of these species are to be found in the Museum of Comparative Zoölogy. Other types are the property of the United States National Museum, where, as far as the material will allow, a duplicate set of specimens of all species will be sent.

General Characters of the Nemerteans.

Proboscis.— The most characteristic feature distinguishing the nemerteans from all other groups of worms is the possession of a highly developed, tubular, eversible proboscis, situated dorsal to the alimentary canal, bathed in a corpusculated fluid enclosed in a special muscular sheath, and opening at the anterior end of the body, sometimes in connection with the mouth and sometimes separately. In many species the proboscis is nearly as long as the body itself; it is lined with glandular epithelium, and in certain genera is provided with rhabdites, nematocysts or highly specialized calcareous stylets of definite size and shape.

Form and size.— The body of the nemertean is commonly long, flattened, and ribbon-like (Cerebratulus), filiform (Cephalothrix, Lineus), broad and flat (Drepanophorus), thick and rounded (Euborlasia), or short and cylindrical (Tetrastemma), but in nearly

all forms is exceedingly contractile, and may often be contracted to one tenth the length of the fully extended worm. In size there is the greatest variation found in any group of worms, for there are minute species (TETRASTEMMA) but 5 mm. long and a half millimeter thick when sexually mature, while another form (*Lineus longissimus*) may become 25 meters in length when fully extended, but is of very slender proportions; another (*Cerebratulus lacteus*) may become 7 meters long and 20 mm. wide, while the single known individual of a species described in this report (*Euborlasia maxima*) was 45 mm. in width after preservation.

Body.— The body of the nemertean is without external segmentation, although many of the internal organs are metamerically arranged; and it is devoid of setae, parapodia, or other external appendages (except in a single known species, NECTONEMERTES). The body is covered throughout with glandular and ciliated cells, as in the Turbellaria. A true body cavity is wanting, the space between the muscular walls of the body and the intestine being filled with gelatinous tissue, or parenchyma.

Alimentary canal.— The mouth is situated anteriorly either in front of the brain in the Hoplonemertea, or immediately behind it in the other two orders. The alimentary canal extends the whole length of the body, being in most of the genera provided with paired lateral diverticula, and sometimes with other appendages, and having the anus at the posterior end of the body.

Blood system.— The blood vascular system consists of a pair of closed lateral vessels extending the whole length of the body, together with a similar median dorsal vessel in most forms; these are all connected in the head by anastomosing lacunae, and in many species are united throughout the intestinal region by regularly arranged transverse vessels situated above and immediately outside the intestinal diverticula. In certain genera there are additional vessels and lacunae in the esophageal region. The blood vessels are usually without muscular walls, the blood itself, with its contained corpuscles, which are sometimes colorless and sometimes red in color, being circulated back and forth in the same vessels through the body by the general contractions of the body musculature.

Nephridia.— The excretory system usually consists of a pair of lateral canals with numerous branches, which sometimes end in so-called "flame" cells, similar to those of the Turbellaria, and enter

into close relation with the lateral blood vessels or lacunar diverticula of same, but with which they have no actual communication. One or more efferent ducts usually lead from each nephridial canal to the exterior of the body. Most commonly the nephridia are limited to a comparatively short area in the esophageal region, but in some forms (STICHOSTEMMA) extend the whole length of the body. In most species of Hoplonemertea the nephridiopores are situated ventral to the lateral margins of the body, while in most species of the other groups they lie on the dorso-lateral aspects of the body.

Nervous system.— The central nervous system is made up principally of a four-lobed brain, the two lobes of each side being closely united with each other and joined to those of the other side by a commissure above and one below the rhynchodaeum, and a pair of large lateral nerves, accompanied by ganglion cells, extending from the ventral pair of brain lobes to the posterior end of the body. The lateral nerves are connected at intervals by a nervous plexus, and at the posterior end of the body by a distinct commissure usually situated dorsally to the anus. In addition, a dorso-median nerve is commonly present, and sometimes a ventro-median one; most forms have a pair of well-developed esophageal nerves, and nearly all have special proboscis nerves, together with peripheral nerves to the integument, ocelli and other sense organs.

Sense organs.— A pair of specialized cerebral sense organs is often present as posterior appendages of the dorsal brain lobes (Heteronemertea), or they may lie anterior or beside the brain in the other orders; in only a few forms are they wanting. Other special sense organs are found on the lateral margins of the body in many of the Paleonemertea. Ocelli are often present in great numbers, but are wanting in the Paleonemertea and in many species of the Heteronemertea. A few species possess otoliths; some have a specialized frontal sense organ, while several species of CARINOMA possess a number of sensory pits on the dorsal aspect of the head.

Reproductive organs.— The sexes in most species of the nemerteans are separate, although a few forms, *Tetrastemma caecum*, for example, are hermaphroditic and some are protandric. The genital glands are simple sacs which develop in the body parenchyma, and when the sexual products are mature open directly to the surface of the body. In many forms which have broad, lateral, intestinal

diverticula, a single pair of gonads develops between each pair of these intestinal appendages. A few species are viviparous.

Development.— In the larval development, some forms (Lineidae) pass through a complicated metamorphosis, with the formation of a free-swimming larva of highly specialized form (pilidium, or Desor's larva), but in other forms (Amphiporus, Cephalothrix) development is direct, or is accompanied only by a shedding of the larval integument.

Habits.— Nearly all species are marine, living under stones, among algae, or in burrows in the sea bottom or shore between tides; representatives of a single widely distributed genus (Stichostemma) live in fresh-water pools, ponds, or rivers, and several species live in moist earth in warm climates; a few forms are commensal, inhabiting the mantle chambers of lamellibranchs or of ascidians, while the members of a single genus (Carcinonemertes) are truly parasitic, living among the gill plates or egg masses of various species of crabs.

Anatomical and Histological Structures, with Special Reference to the Pacific Coast Species.

The anatomical and histological peculiarities of the various organ systems of the nemerteans as they were known previous to the year 1895 have been presented by Bürger ('95; '97–:03) in so detailed and comprehensive a manner that it will be necessary in this article merely to call attention to those features which have come to light from more recent studies, and especially to those peculiarities in which the Pacific coast forms differ from those species which have been previously described.

These peculiarities may best be presented in a brief sketch of the different organ systems of the nemerteans, in which the deviating characters found in the Pacific coast forms, described on the following pages, shall be included. The order of arrangement is the same as that adopted by Bürger, in his Monograph of the Nemerteans of the Gulf of Naples, which has been freely consulted in the preparation of this chapter. To this monograph the reader is referred for a comprehensive and detailed account of those anatomical peculiarities of which it seems necessary to give here but a brief description, extended only so far as to render intelligible the deviating characters of the Pacific coast forms.

Integument.

The body wall of the nemerteans consists of an outer integument, composed of ciliated, glandular, and interstitial cells, and of a series of two or more layers of muscles.

The *integument* is composed of highly columnar, often club-shaped cells arranged irregularly in a single layer; many of the cells do not reach the surface, however, and others lie quite superficially, these latter being attached among the underlying cells by long fibrous processes (Text-fig. 1).

The ciliated cells are commonly club-shaped and are covered on the outer, broader end with numerous delicate cilia. The nucleus of each of these cells is situated in the narrowed neck of the cell and well away from its free border. The cell is commonly continued much further beneath the nucleus as a slender, root-like process, which often twists about among the bases of the neighboring cells and ends near the basement membrane (Text-fig. 1, *b*).

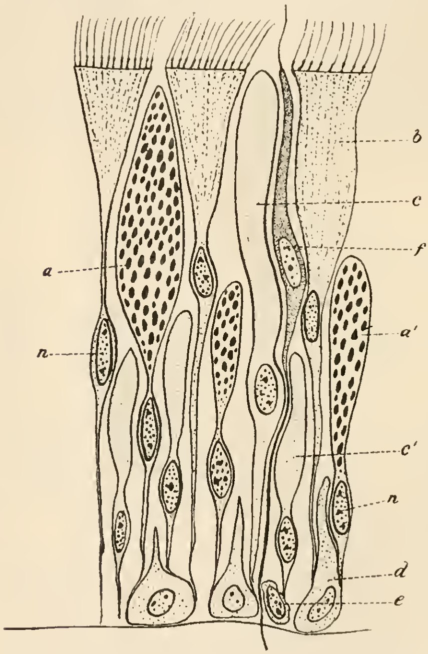

Fig. 1.—Diagram of cellular elements of integument; *a*, *a′*, club-shaped gland cells with coarse, granular secretion; *b*, goblet-shaped ciliated cells; *c*, rod-like glands with clear, homogeneous secretion of very firm consistency; *d*, basal cells for the replacement of overlying gland cells; *e*, undifferentiated basal cell; *f*, specialized sensory cell with single cilium; *n*, nucleus.

The glandular cells are irregularly disposed among the ciliated cells, and are sometimes fewer and sometimes more numerous than the latter. There are often two or more kinds of gland cells in the same portion of the body, and they may be distinguished not only by differences in shape and by the microscopic character of the secretion, but also by differences in their reaction towards various stains.

One type of these gland cells stains most deeply with nuclear stains, the cell is flask-shaped and is filled with a more or less coarsely granular or foamy secretion (Text-fig. 1, *a*, *a'*), while the other type (Text-fig. 1, *c*, *c'*) stains chiefly with plasma stains, the cell is rod-like in shape and contains a homogeneous, viscid secretion, which is often found pressed out of the cell body and lying among the cilia on the surface of the integument. A third type of gland, found in many species, consists of clustered gland cells which pour their viscid secretion out through a common passage among the more superficial cells. This type of gland cell may lie deep in the integument, as in Carinella, or may sink beneath the basement layer to lie among the muscular fibers of the body walls, as in Taeniosoma and the Lineidae. Or, similar glands may sink into or even entirely through the muscular layers of the body walls to form the sub-muscular glands of the Hoplonemertea (Text-fig. 3). The glands of this type commonly show a marked affinity for nuclear stains, and their secretions are in many cases distinctly colored in the living worm, thereby affecting the natural coloration of the body.

The arrangement of the ciliated and glandular cells, as well as the thickness of the integument, is decidedly varied in the different orders. For details of these peculiarities, compare Bürger's Monograph ('95), p. 204–216.

Among the bases of the glandular and epithelial cells are numerous interstitial cells, some of which are of the nature of connective tissue elements, while others are strictly epithelial (Text-fig. 1, *d*, *e*). These interstitial cells are commonly profusely branched and serve to bind the other integumental cells together.

In the species of Zygonemertes characteristic sickle-shaped or rod-like masses of homogeneous, hardened secretion of pale yellow color are situated among the outer borders of the epithelial cells, while somewhat similar bodies are found in *Amphiporus bimaculatus* and *A. imparispinosus.* They are especially conspicuous in *Emplectonema echinodermum* of Europe, and in all cases appear to originate as secretions in glandular cells of the integument.

Specialized sensory cells of very slender form and provided with a single flagellum occur at frequent intervals among the ciliated and glandular cells (Text-fig. 1, *f*).

Other sensory cells are scattered throughout the integument, and

are massed together in certain regions to form specialized sense organs, which are described below.

Longitudinal and transverse muscular fibers occur in the midst of the integument of the species of Carinoma, while in the Lineidae similar integumental muscles occur immediately beneath the epithelial cells.

Pigment.—The interstitial cells are often filled with pigment granules, which commonly impart the peculiar coloring to the body, and are often arranged in such a manner as to form distinctive spots, lines, bands, or rings, characteristic of the different species.

In other forms (as *Tetrastemma bilineatum*) the pigment cells, which determine the characteristic markings of the body, have wandered beneath the integument, and have become situated in localized areas in the midst of the muscular walls.

In certain other species (as *Cerebratulus marginatus*) the color of the glandular secretions of the integument determines to a great extent the natural color of the body, while in still other forms the muscular layers are distinctly colored.

Basement Layer and Cutis.

Basement layer.—In all nemerteans belonging to the Paleonemertea and Hoplonemertea, a layer of homogeneous hyaline connective tissue is situated immediately beneath the integument, and in most species of these groups forms a conspicuous basement layer (Pl. **13**, figs. 81, 82). In some species the basement layer is fully equal to the integument in thickness, while in other forms of the same genus it may be but a small fraction of the thickness of the integument.

Numerous minute nuclei and a few delicate fibers are scattered in this homogeneous basement layer, which is usually much more highly developed anteriorly than towards the posterior end of the body. This layer is thrown into folds and branching processes externally to give a firm support to the integumental cells which rest upon it. In the Heteronemertea, a fibrous network of connective tissue takes the place of the homogeneous basement layer of the three other orders.

Cutis.—In most species of the Heteronemertea this network of connective tissue fibers becomes of a very considerable thickness,

and constitutes a more or less definite cutis. In certain forms (TAENIOSOMA and a few of the Lineidae) the cutis consists of a very massive framework of connective tissue supporting an abundance of compound glands, while in most other heteronemerteans the connective tissue is partly replaced by longitudinal muscles.

In TAENIOSOMA the cutis usually presents two distinct layers, of which the outer is closely packed with compound or clustered glands, doubtless homologous with those of the integument of the Paleonemertea. These cutis glands have a great affinity for haematoxylin stains, and each gland consists of a group of 6 to 20 or more pear-shaped gland cells, all of which pour their secretions into usually a single duct which passes to the surface of the integument. The inner layer is made up of a thick mass of connective tissue, commonly composed of coarse fibers, but sometimes giving place to delicate fibrils imbedded in a gelatinous matrix.

In most species of the Lineidae, the connective tissue to a great extent gives place to longitudinal muscular fibers, which surround the compound glands and which lie immediately outside the longitudinal muscles of the body walls. In many of the Lineidae the longitudinal muscles of the cutis are often so intimately connected with those of the body walls that any sharp line of demarcation between cutis and body musculature is impossible, and, indeed, in many cases the cutis glands sink completely beneath the longitudinal muscular layer of the body wall to lie against the nervous plexus immediately external to the circular muscular layer. Two distinct varieties of glands, of which one is simple and the other compound, often occur in the cutis of the same species.

The thickness of the cutis often equals that of the integument, and may in some instances become several times as great. As a rule, the thickness is much greater in TAENIOSOMA than in the Lineidae, and is greater in the anterior than in the middle and posterior portions of the body. In ZYGEUPOLIA and numerous other forms of the Lineidae, any distinction between the cutis and the outer longitudinal muscles of the body wall would be merely artificial.

Between the integument and the cutis in most nemerteans a double set of subepithelial or integumental muscles is developed. These consist of a very thin outer layer of circular fibers, and a somewhat thicker, but yet delicate, layer of longitudinal muscles.

Musculature.

In all nemerteans the body walls are provided with at least two layers of powerful muscles. In the Paleonemertea and Hoplonemertea there are but two distinct muscular layers extending throughout the whole length of the body, although one or more additional layers may occur in some species of the Paleonemertea, in certain portions of the body, as described below. The outer of these is circular and the inner longitudinal. In the Heteronemertea a third distinct layer, consisting of longitudinal fibers, is placed outside the other two layers. The musculature of Malacobdella is closely similar to that of the Hoplonemertea.

In *Paranemertes californica* the longitudinal musculature for some distance behind the head consists of two distinct layers of fibers (Text-fig. 6), separated by a thick layer of parenchyma. They become united into a single musculature well back toward the intestinal region.

Diagonal muscles.— In numerous species belonging to each of the principal orders, a double layer of diagonal muscles (Pl. **12**, fig. 79) is situated between the two principal muscular layers, where but two are present, or between the circular and outer longitudinal layers in the Heteronemertea where three layers occur. The diagonal muscles are nearly always very thin as compared with the thickness of the principal muscular layers.

In the cephalic region of the Heteronemertea and many of the Paleonemertea, the arrangement of the muscular layers is broken up to form a complex network of fibers running in all possible directions, but of which the longitudinal fibers are the most numerous. In other forms the two muscular layers extend forward into the head.

Inner circular muscles.— In many species of Carinella, Micrura, Zygeupolia, and especially in Carinomella and Carinoma, in addition to the outer circular and the longitudinal muscular layers, another layer — inner circular — is developed internal to the longitudinal layer in certain portions of the body. In a few species of Carinella this inner circular muscular layer extends from the head to the posterior end of the body, but in other species of the same genus, in Carinomella (Pl. **7**, figs. 55, 56), and in Carinoma (Pl. **13**, fig. 82), this layer becomes enormously

thickened in the nephridial region, or immediately anterior to the intestinal region, and then ends abruptly at the beginning of the intestinal region, or continues backward merely as a few scattered fibers.

Where the inner circular muscle is developed, crosses between it and the outer circular layer are often formed on the dorsal side of the body, and sometimes also on the ventral side (Pl. **13**, fig. 81). These muscular crossings are especially well developed in CARINELLA.

In *Amphiporus punctatulus* and to a less extent in *Taeniosoma punnetti* a conspicuous layer of inner circular muscles closely invests the posterior portion of the rectum (Pl. **21**, fig. 134) and forms a well-marked anal sphincter.

In ZYGEUPOLIA and in certain species of MICRURA this inner circular muscle is found only for a short distance immediately anterior to the intestinal region, where it reaches a considerable thickness, and then suddenly ceases, exactly as in CARINOMA.

Dorso-ventral muscles.— In all nemerteans a few radial and dorso-ventral muscular fibers are to be found in almost all parts of the body. The dorso-ventral muscles are especially well developed in the intestinal region of CEREBRATULUS and other forms which are very much flattened posteriorly. In such species they form distinct, flattened bands, placed perpendicularly to the axis of the body, and extending between the ventral and the dorsal portions of the body musculature. These bands alternate regularly with the intestinal lobes and extend from the periphery of the lobe to the axial tube of the intestine, thus corresponding in width to the depth of the intestinal lobe. With the development of the sexual glands, the dorso-ventral muscles are split vertically, the sexual glands developing between the two portions, showing that each dorso-ventral band is in reality composed of two distinct bands of fibers.

In *Amphiporus punctatulus*, which is much flattened and adapted for swimming, strong bands of such muscles occur throughout the posterior half of the body, and are particularly well developed in the region of the rectum (Pl. **21**, fig. 132).

In all forms, moreover, in which intestinal lobes are developed, there are more or less distinct bundles of these dorso-ventral muscular fibers alternating with the intestinal lobes. This dorso-ventral musculature is probably homologous with the inner circular muscle of the Paleonemertea.

In *Carinella linearis* and in Carinomella a very strong band of longitudinal muscles (Pl. 8, figs. 57, 58), continuous with the longitudinal muscles of the proboscis sheath more anteriorly, extends beneath the posterior portions of this sheath for some distance into the intestinal region, and eventually fuses with the principal longitudinal muscular layer (Pl. 9, fig. 59) of the body wall. These muscles are also to be found in other species of Carinella and in Carinoma, but in a very rudimentary condition.

Each muscle fiber consists of a single cell, with an extremely small, slender nucleus, surrounded by an insignificant amount of undifferentiated cytoplasm. This minute cell body lies upon, or imbedded in, the fiber of contractile substance.

Connective Tissues and Parenchyma.

Everywhere in the body of the nemertean is a complex network of connective tissue fibers surrounding and supporting the other histological elements. In the muscular layers the connective tissue fibers form a considerable proportion of the tissue, and similar fibers make up the great bulk of the cutis. In the cutis of many forms the fibers are imbedded in, and in part replaced by, a closely related gelatinous tissue.

A somewhat similar tissue fills all the space inside the body walls not occupied by the viscera, so that a body cavity homologous with that of the annelids is wanting. This gelatinous tissue is termed the body parenchyma, or mesenchyma.

In some forms there is comparatively little of this parenchyma, the viscera lying closely appressed to the inner border of the body walls, but in some other species (as in *Amphiporus gelatinosus*) the mass of parenchyma in the esophageal region becomes several times as voluminous as the esophagus (Pl. 19, fig. 120), and continues with but little diminution to the posterior end of the body (Pl. 20, fig. 122). In the head, too, a very thick layer of this tissue separates the brain from the muscular walls of the head, which have but a fraction of the thickness of the parenchyma in the same region (Pl. 19, fig. 119). The great bulk of the substance of the head therefore consists of parenchyma, and this is but little less true of the other portions of the body.

As a rule, this tissue is most conspicuous in the Hoplonemertea,

especially in DREPANOPHORUS, PELAGONEMERTES, and certain species of AMPHIPORUS, and in MALACOBDELLA.

In the Heteronemertea the parenchyma is much reduced in the head region, and is better developed between the intestinal lobes than in any other portion of the body, but is nowhere very abundant.

The genital glands develop in this parenchyma, and when fully mature occupy nearly the whole of the space in the intestinal region between the intestine and the body walls, or between adjacent intestinal lobes where these are developed, so that at the time of sexual maturity the parenchyma is greatly reduced in amount and extent.

The elements of which the parenchyma is composed consist of small, irregularly branched cells (Pl. 20, fig. 124) and a relatively vast amount of gelatinous secretion. The branching cells have small oval nuclei and their processes ramify throughout the gelatinous secretion in which they are imbedded, often uniting together, as Montgomery ('97, p. 14) has so fully described for CEREBRATULUS, and thus forming an irregular network. The cell bodies are commonly filled with vacuoles and granules of various sizes, and exhibit the greatest variation in size and shape (Pl. 20, fig. 124).

The protoplasmic boundaries of the cells are often so faintly marked that it is impossible to determine the exact extent of the cell body.

In life the parenchyma is almost perfectly transparent, and in the pelagic nemerteans is said to resemble the jelly of the Medusae.[1]

Cephalic and Submuscular Glands.

Cephalic glands.— In nearly all species of nemerteans one or more groups of specialized gland cells are situated in the cephalic tissues, and open either by a single or by numerous ducts on the tip of the snout.

These cephalic glands resemble the compound cutis glands in general structure and in their behavior towards stains, showing great affinity for haematoxylin. They are, as a rule, especially well developed in the Hoplonemertea, and in some forms, *Carcinonemertes epialti*, for example (Text-fig. 9), occupy the greater bulk of the tissues of the head in front of the brain.

[1] For further details, see Montgomery ('97), and Bürger ('95 and '97–:03).

In many other species, although the cephalic glands may be less voluminous in front of the brain, yet they extend far back into the esophageal region. In certain species of CARINELLA (*C. rubra*, Text-fig. 2) these glands occupy a thick layer about the cephalic blood lacunae as far back as the brain region, while a layer of similarly deeply staining glands closely surrounds the rhynchodaeum. In other species (*C. frenata*) they occur only immediately about the rhynchodaeum. In still other forms of the same genus (*C. albocincta*) an intermediate condition may exist, for those glands situ-

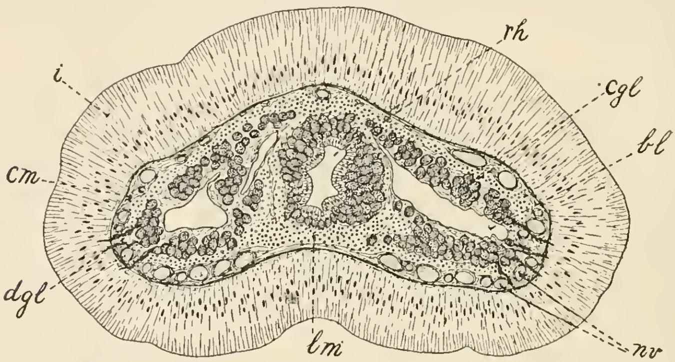

FIG. 2.— *Carinella rubra*. Transverse section through head in front of brain showing enormously developed cephalic glands both above and below cephalic blood lacunae (*bl*), and around rhynchodaeum (*rh*); *nv*, cephalic nerves.[1]

ated in the wall of the rhynchodaeum may discharge their secretions directly into the cavity of the rhynchodaeum, and are not usually termed cephalic glands, although they are perfectly similar in character and doubtless have the same origin as the latter. The true cephalic glands in nearly all instances open by a single, or occasionally by numerous ducts ending on the tip of the snout immediately over the proboscis pore.

In the Heteronemertea they are particularly well developed in TAENIOSOMA, where they occupy a great part of the tissues of the head in the brain region, and stretch backward above this organ for some distance into the esophageal region. They are commonly much more closely massed in the dorsal than in the ventral portion

[1] For references not mentioned under the text figures see the Explanation of Plates.

of the head. Their secretions are discharged mainly into the tubular frontal organ.

In the Lineidae the cephalic glands do not extend behind the anterior border of the brain except in a few species, and they are commonly limited to the dorsal portion of the head except for a short distance near the tip of the snout, where they occur also in the ventral portion.

In *Lineus rubescens* a peculiar condition prevails, for here a very conspicuous duct lies directly beneath the rhynchodaeum and leads forward from the more posterior glands, to discharge their secretions on the tip of the snout beneath the proboscis pore.

In Geonemertes these glands are enormously developed, and

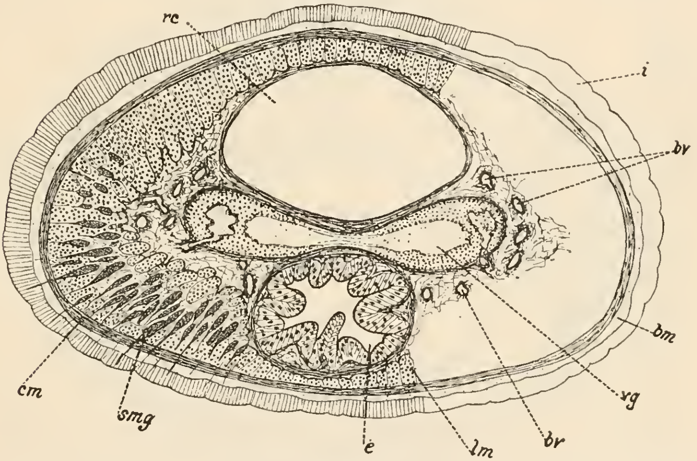

Fig. 3.—*Amphiporus nebulosus.* Transverse section through ventral commissure of brain, showing very numerous submuscular glands (*smg*) occupying a large portion of tissues of ventral half of body; *e*, stomach; *rc*, rhynchocoel.

discharge their secretions into a large, tubular pit, situated immediately dorsal to the rhynchodaeum. This pit not only discharges the secretions from the cephalic glands, but also serves as a highly specialized sense organ (von Kennel, '78; Coe, :04).

Submuscular glands.—In many species of hoplonemerteans more or less numerous glands are found which in form and function resemble the true cephalic glands, but which are situated in the body parenchyma between or beneath the muscular layers of the body

walls. These constitute the so-called submuscular glands, and discharge their secretions directly through the overlying muscular layers to the surface of the body.

The submuscular glands are usually limited to the head region of the body (Text-fig. 19), but in some instances extend backward throughout nearly the whole length of the esophageal region, as in *Amphiporus nebulosus* (Text-fig. 3), or quite to the intestinal region, as in *Emplectonema bürgeri*. As is the case with the true cephalic glands, the submuscular glands are compound, each consisting of a number of gland cells having a common duct leading to the exterior (Pl. **20**, fig. 123).

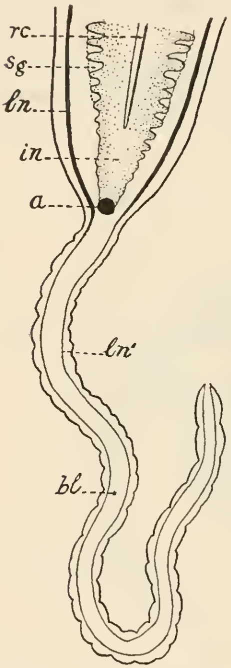

FIG. 4.—*Zygeupolia littoralis* Diagram of posterior end of body, showing caudal cirrus with large central blood lacuna (*bl*); *ln*, lateral nerve, extending into caudal cirrus (*ln'*); *rc*, rhynchocoel; *sg*, sexual gland; *in*, rectum; *a*, anus. *After* C. B. Thompson.

Caudal Cirrus.

In addition to the pair of peculiar cirri which Verrill ('**92**) has described for NECTONEMERTES, and which are situated immediately behind the head, the only appendage found on the body of any nemertean is the caudal cirrus, or caudicle.

This appendage is found only in the genera VALENCINURA, ZYGEUPOLIA, MICRELLA, MICRURA, CEREBRATULUS, and DIPLOPLEURA, all belonging to the Heteronemertea. It represents a slender prolongation of the body beyond the opening of the alimentary canal. This organ has been very fully studied in ZYGEUPOLIA by Miss Thompson (:**02**), who finds it to be provided with both circular and longitudinal muscles more or less continuous with the two inner muscular layers of the rest of the body, with slender prolongations of the lateral nerves (Text-fig. 4), and with a large central blood space connecting both with the dorsal and with the lateral blood vessels of the body. The outer longitudinal musculature, cutis, rhynchocoel, alimentary canal, and sexual organs are wholly wanting.

Punnett (:01[b]) has found a very similar condition in MICRELLA, and both these authors agree that the anus is situated dorsally to the base of the caudal cirrus, while Bergendal (:02[a], p. 47) was inclined to the opinion that the anus is situated ventrally in VALENCINURA, although his sections did not allow him to determine this point with certainty.

Alimentary Canal.

In all nemerteans the alimentary canal consists of a single, more or less distinctly ciliated tube extending practically the whole length

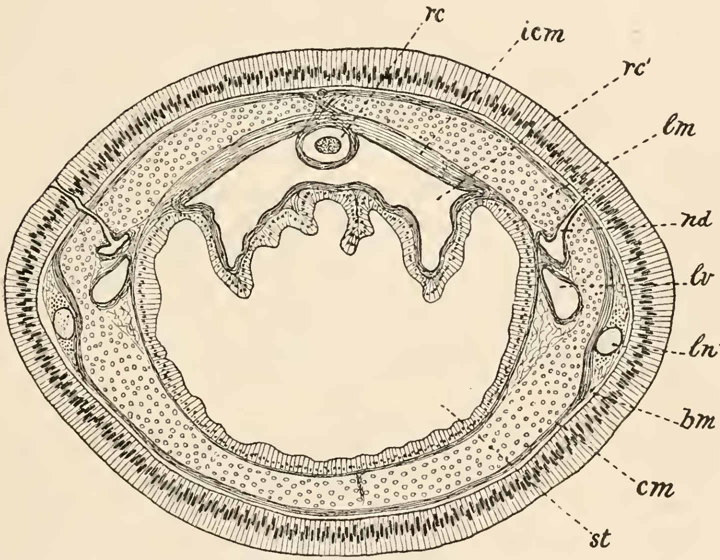

FIG. 5.—*Carinella frenata*. Transverse section of body in region of nephridiopores, showing cavity of stomach (*st*) and enlarged blind sac of rhynchocoel (*rc'*) with smaller, posterior chamber of rhynchocoel (*rc*) above it; *nd*, efferent nephridial duct.

of the body. The mouth is small and situated subterminally on the tip of the snout in the Hoplonemertea, where it opens with or near the rhynchodaeum. In the other orders it is of larger size, often an elongated slit, and is situated posterior to the brain commissures. Only in the genus CEPHALOTHRIX is it placed far behind the brain. The anus usually opens dorsally at or near the posterior extremity of the body.

In many of the Paleonemertea the digestive canal is a simple cylindrical tube without any diverticula whatever (Text-fig. 5), but in other genera of this order, and in all members of the other orders, except MALACOBDELLA, this tube exhibits closely placed, paired, lateral lobes, or pouches, throughout the middle and posterior portions of the body. These metameric pouches arise from a flattening and widening of the canal, correlated with the constriction of bands of tissue at regular intervals, thus giving rise to alternating wider and narrower segments. These pouches are deepest in the flatter and wider forms of both the Hoplonemertea and Heteronemertea and reach their greatest development in DREPANOPHORUS, CEREBRATULUS, and LANGIA, where the central cylindrical tube is but a small fraction of the width of the intestinal pouches. An intermediate condition occurs in CARINOMELLA, where more or less regularly arranged pouches are present when the body of the worm is contracted (Pl. **10**, figs. 63–65), but largely or wholly disappear when the body is well extended.

In some species of PARANEMERTES, CEREBRATULUS, and other genera the intestinal lobes are forked once or twice distally, and in PELAGONEMERTES they are profusely branched. The digestive tube is further complicated by the presence of a large caecal appendage in most Hoplonemertea, as described below.

A. **Paleonemertea and Heteronemertea.** — In the Paleonemertea devoid of lateral intestinal lobes there are no distinct morphological divisions to the alimentary canal, although the histological features vary in its different portions. In the other Paleonemertea and in the Heteronemertea the mouth, situated immediately behind the brain, opens into a long esophagus, or fore gut, the posterior portion of which is usually differentiated histologically, and sometimes morphologically, to form a second chamber, the "stomach." This latter opens into the intestine proper, or mid gut, with its paired metameric pouches. Near the anus the pouches become gradually smaller and in a few forms, as CARINOMA (Pl. **12**, fig. 77), a considerable terminal portion is devoid of diverticula, forming a distinct rectum, or hind gut. In most nemerteans, however, this portion of the digestive tract is very inconspicuous.

Buccal cavity and *esophagus.* — The mouth is lined with highly columnar, ciliated and glandular cells, and opens into a broad esoph-

agus with greatly convoluted walls, the epithelium of which is several times as thick ventrally as dorsally. The epithelium of the lips is very thick and closely packed with gland cells. In the mouth and esophagus two more or less distinct varieties of glands can be distinguished, due to the different nature of the secretion in each variety. Both kinds are slender, the nucleus of each cell being placed beneath the cell body in a narrow stalk which attaches the cell to the underlying basement membrane. One variety shows a homogeneous, often deeply staining secretion and is more or less rod-like in form. The other variety is characterized by goblet-shaped cells with a much more granular secretion.

The ciliated cells are superficially placed; they are likewise goblet-shaped with a slender stalk for attachment, and with the nucleus at the base of the cell-body, but yet not far from the surface of the epithelium, because the ciliated cells are situated above the gland cells. The cilia in this region are short but very numerous.

In the mouth certain glands often sink beneath the others, or may form a distinct ring about the lips. They form a secretion with peculiar staining properties, which is poured into the buccal cavity; they are known as salivary or buccal glands.

In *Micrura alaskensis* similar glands sink inward beneath the adjacent musculature and become situated in the outer longitudinal muscular layer, although they nevertheless pour their secretions into the buccal cavity. These have been called accessory buccal glands (Coe, :**01**, p. 72).

Stomach. — The stomach is usually decidedly different in its histological structure from the esophagus proper, and in *Lineus rubescens*, *L. flavescens*, and other forms, is separated from the latter by a strong muscular constriction, forming a conspicuous sphincter. In *Carinoma mutabilis* (Pl. **12**, fig. 76) there is a similar boundary line between esophagus and stomach. In such cases the histological change is very abrupt; in others it is more gradual. In the stomach[1] a comparatively small proportion of the cells are ciliated; the cilia are longer but fewer in number, and their nuclei are much farther removed from the surface, being situated in the very slender basal stalk which attaches the cell to the underlying basement membrane.

The gland cells are usually packed full of secretion which is com-

[1] Compare Miss Thompson's description of ZYGEUPOLIA, :**02**, p. 709.

monly forced partly out of the cell bodies so that their outlines are often difficult to determine. At its posterior end the stomach of Carinella, Carinoma (Pl. 12, fig. 76; Pl. 13, fig. 82), Carinomella (Pl. 8, fig. 57), and certain heteronemerteans is constricted and its lumen rendered very small by the massive development of the inner circular muscle.

Intestine. — The change from stomach to intestine is often very gradual, the most anterior lateral pouches being very rudimentary and increasing gradually in depth. This is well shown in Carinoma (Pl. 12, fig. 76). The epithelium characteristic of the stomach often persists, especially in the central canal, behind the small anterior pouches even after the latter have taken on the peculiar intestinal character. The anterior portions of the intestine are characterized by a wide central lumen and comparatively shallow pouches, while its posterior portions have very deep pouches and a narrow axial lumen. The sexual glands and dorso-ventral muscles alternate with the intestinal pouches, while the blood vessels of the Herteronemertea and the rhynchocoel appendages of Drepanophorus lie opposite them.

The most striking peculiarity of the epithelium of the intestine, or mid gut, is that it is composed of a single layer of very tall columnar cells, each of which reaches quite to the basement layer and is packed full of globules and granules of various sorts. These cells are actually provided each with a few very long cilia of such delicacy that they are seldom distinguishable in prepared sections, although they are readily demonstrated in life. They are not gland cells, as are those of the more anterior portions of the alimentary canal, but are rather of the nature of absorbing and assimilative cells. The substance composing the body of each cell is very different in appearance from that of any of the cells in other parts of the digestive tract, and its appearance varies greatly not only in different species but in different individuals, and doubtless also at different times in the same individual, according to the nature of the food and the state of its digestion.

In some instances when examined in life after crushing, most of the cells are packed full with clear vacuoles, others contain granules of various sorts, some of which are opaque, others being of a certain color, as black, brown, yellow, or green. In *Paranemertes californica*, for example, the cells contain vast numbers of fine granules

of a deep green color, and these impart the characteristic coloring to this portion of the body. The pigment is in this instance quite insoluble in alcohol, ether, xylol, cedar oil, or any of the commonly employed clearing reagents.

In many forms very numerous highly refractive globules, apparently similar to fat or oil drops, are encountered, and other vacuoles of fluid suggest food materials being stored up or in process of assimilation. Other cells contain various concretions and sometimes crystals. The body of the cell is so crowded with these apparently non-living substances that there seems to be but little space for the

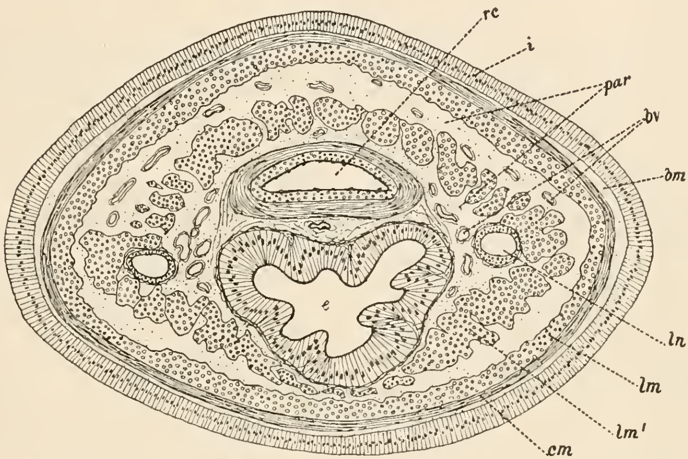

FIG. 6.—*Paranemertes californica.* Transverse section of body a short distance behind brain, showing stomach (*e*), proboscis sheath (*rc*), and the two distinct layers of longitudinal muscles (*lm* and *lm'*) of body walls separated by a thick layer of parenchyma (*par*).

cytoplasm. The nucleus is usually extremely minute and is situated near the base of the cell.

The rectum is similar to the intestine proper in histological structure.

The lining of the mouth, esophagus and stomach is, so far as is known, always derived from the ectoderm of the embryo, while the epithelium of the intestine proper and rectum is entodermic in origin.

B. **Hoplonemertea.**—In this order the mouth is comparatively small and usually closely connected with the rhynchodaeum, although in DREPANOPHORUS it is situated a little behind the open-

ing of the latter, and in some species both these openings are united in a broad atrium. Usually, however, the esophagus branches out directly from the ventral wall of the rhynchodaeum.

From its point of origin, which may be near the tip of the snout or back nearly to the brain, the esophagus passes posteriorly as a narrow tube beneath the ventral brain commissure, behind which it abruptly enlarges into a broad chamber, the stomach (Text-fig. 6). The epithelium of the esophagus is thin and composed mainly of ciliated cells, although gland cells also occur in comparatively small numbers. The ciliated cells are covered with closely placed but short cilia.

Stomach. — The stomach (Text-figs. 3, 6, 15, 16, 17, 19), situated immediately behind the brain, is broad, with greatly convoluted walls and lined with a thick layer of ciliated and glandular epithelium very similar to that described for the heteronemerteans. Posteriorly the stomach continues into a long narrow tube, the pylorus, situated immediately ventral to the proboscis sheath.

Pylorus. — This tube (Pl. 20, fig. 121) does not open into the anterior end of the intestine, or mid gut, but passes a considerable distance backward and opens through the dorsal wall of the intestine, often far back of its anterior end. The anterior portion of the intestine, therefore, extends forward beneath the pylorus and ends blindly anteriorly, forming the intestinal caecum. The histological features of the pylorus resemble those of the stomach except that the epithelial cells are shorter and consist of a much larger proportion of ciliated cells, the gland cells almost disappearing at its posterior end.

Intestine. — The broad intestinal canal is provided with deep lateral pouches and with histological elements very much like those described for the Heteronemertea.

Intestinal caecum. — The blind portion of the intestine extending forward beneath the pylorus exhibits the same morphological and histological structure as the intestine proper. In many species of Amphiporus and in other genera the caecum extends anteriorly beneath the stomach, and its pouches often reach as far forward as the dorsal border of the brain lobes. The lateral pouches of the caecum (Pl. 20, fig. 121) are usually more slender than those of the intestine proper and extend laterally in the parenchyma beside the pylorus and proboscis sheath and above the lateral nerves. They

are often forked distally, the branches extending forward far in front of their point of origin.

Near its anterior end the main axial caecum often sends off one or two pairs of large lateral pouches, which commonly branch irregularly, the more anterior pair extending forward far in front of the anterior end of the axial caecum itself. It is these anterior, lateral branches which in many species extend as far as the brain lobes (Pl. 16, fig. 97).

Esophageal caecum.— In two species of AMPHIPORUS which are described in this paper (*A. occidentalis* and *A. rubellus*) the alimentary canal is further complicated by the presence of a very conspicuous caecal appendage to the esophagus in addition to a highly developed intestinal caecum. In both these species the narrow esophagus passes beneath the ventral brain commissure and divides into two branches (Pl. 20, fig. 121), one situated directly dorsal to the other. The dorsal branch passes into the stomach, while the ventral branch enlarges to form a large tubular chamber which may be called the esophageal caecum (Pl. 20, fig. 121), for it is lined with the same kind of epithelium as is the esophagus, and ends blindly posteriorly. This esophageal caecum extends posteriorly in the median line nearly to the most anterior sexual glands.

In one of the specimens of *A. occidentalis* it was further complicated by bending forward in the median line to form a narrow appendix (*app.* Pl. 20, fig. 121), which has a very narrow lumen and highly glandular walls.

A transverse section of the body in the region of the appendix shows, therefore, sections of four distinct portions of the alimentary canal (Pl. 20, fig. 121), viz., the stomach, intestinal caecum, esophageal caecum, and appendix. The stomach, esophageal caecum, and appendix all lie in the median line, one directly above the other, while the branches of the intestinal caecum are situated laterally.

Cardiac caecum.— Still further complications occur in *Amphiporus occidentalis*, for the stomach into which the dorsal branch of the esophagus opens, as described above, extends forward above the esophagus as a broad, bulb-like chamber which ends blindly between the posterior ends of the brain lobes. This chamber may be called the cardiac caecum (Pl. 20, fig. 121), representing as it does an anterior extension of the stomach. It is possible that it is little more than an extensive anterior fold,

and that it may largely or wholly disappear when the stomach is widely distended with food. Its histological structure agrees with that of the stomach.

In *Paranemertes californica* the pylorus is extremely short, opening into the intestine at a point only about twice as far behind the brain as the distance from the brain to tip of snout. The intestinal caecum is correspondingly reduced to a few pairs of lateral lobes extending forward for a very short distance in front of the posterior opening of the pylorus. Posterior to the caecum proper the intestine exhibits the same anatomical and histological features as the caecum of related forms, while the intestine proper commences a considerable distance more posteriorly. This condition has evidently arisen from a disappearance of the long, slender pylorus of the typical hoplonemertean, so that the pylorus opens near the anterior end of the long caecum, instead of far back as in most other members of the order.

In Carcinonemertes, which lives on the juices of crabs on which it is parasitic, the intestinal caecum is practically wanting, the stomach being closely connected with the proboscis and transformed into a barrel-shaped chamber which opens directly into the broad intestine posteriorly. The intestinal lobes are also very much reduced.

The lining of the mouth, esophagus, stomach, and pylorus originates from the ectoderm of the embryo, while the intestine and intestinal caecum are entodermic in origin.

C. **Bdellonemertea.**— In Malacobdella the proboscis and esophagus open together into a broad atrium, situated immediately in front of the brain and opening externally at the tip of the snout. The esophagus is large, and is provided with finger-like processes, of which the anterior ones, when fully extended, may be protruded out of the mouth opening, where they are moved to and fro like tactile organs (Takakura, '97, p. 106). The esophagus is constricted before opening into the intestine, which is without lobes or diverticula of any sort, but differs from that of all other nemerteans in being strongly convoluted, and much longer than the body. The anus opens dorsally, above the sucking disk with which the posterior end of the body is provided.

Proboscis and Proboscis Sheath.

The proboscis is attached to the tissues of the head in the region of the brain and extends backward in an outer closed tube, the proboscis sheath, situated in the median line above the digestive tract. This sheath is filled with a fluid in which the proboscis is freely suspended.

The proboscis opens subterminally on or very near the tip of the snout except in the genus VALENCINIA, where the opening is situated back nearly to the brain.

In all except certain species of heteronemerteans (ZYGEUPOLIA, CEREBRATULUS) the proboscis is likewise attached at its posterior end to the wall of the proboscis sheath. This attachment is accomplished by means of two or more strands of longitudinal muscles which become interwoven with the musculature of the sheath.

In the parasitic CARCINONEMERTES (Text-figs. 7, 8, 9) the proboscis sheath is reduced to the merest rudiments, the posterior chamber of the proboscis being imbedded in the adjacent connective tissue of the body. In this form the proboscis extends but a little behind the brain and is so intimately connected with the esophagus that the single stylet with which it is provided can be everted only as far as the opening of the rhynchodaeum, as described elsewhere. With the rhynchodaeum opening pressed against the tissues of the gills of the crab on which this nemertean lives, the stylet can thus puncture the gills. The exuding blood and other fluids are then drawn into the nemertean's stomach where they serve as food.

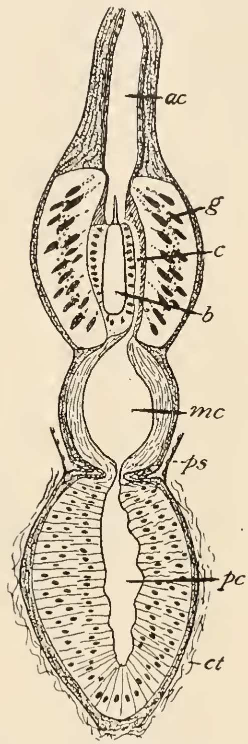

FIG. 7.—*Carcinonemertes epialti.* Optical section of proboscis removed from the worm; *ac, mc, pc,* anterior, posterior, and middle chamber respectively; *g,* gland cells; *c,* canal connecting anterior and middle chambers; *ps,* remnants of proboscis sheath attached to posterior chamber; *ct,* connective tissue in which posterior chamber is imbedded; *b,* basis of central stylet.

In most nemerteans, however, the proboscis can be everted so that it extends for a considerable distance beyond the tip of the snout. When everted the thick inner epithelium with its extremely viscid secretions comes to lie externally, where it can be brought into contact with either the prey or the enemies of the worm.

In the forms provided with a well developed stylet the body of the prey or enemy can be pierced by this, and at the same time held firmly by the extremely tenacious secretion of the anterior proboscis chamber. The secretion of the posterior chamber very probably aids in paralyzing the victim.

In the forms without stylets the proboscis can hold any small object, such as another worm or crustacean, very firmly by coil-

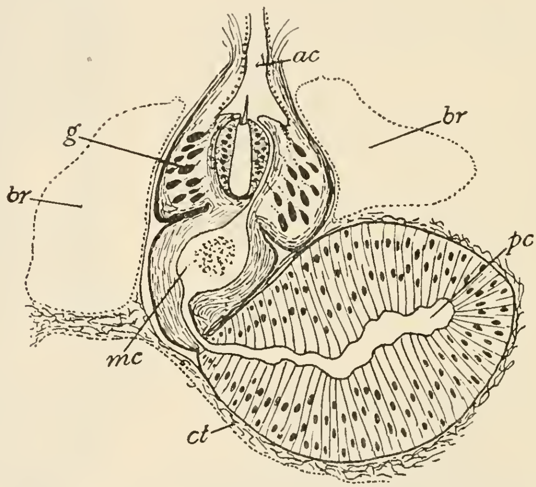

Fig. 8.—*Carcinonemertes epialti.* Horizontal section of proboscis lying in natural position between brain lobes (*br*), and showing posterior chamber at right angles to general axis of proboscis.

ing about it and secreting its tenacious mucus. Various sorts of stinging hairs, or nematocysts, aid in the capture of the prey in certain species, as described below.

In many forms the proboscis further aids the worm in burrowing. C. B. Wilson (:00, p. 105) describes a specimen of *Cerebratulus lacteus* in the process of burrowing as everting its proboscis for a distance of six or eight inches into the mud in advance of the head of the worm.

Rhynchodaeum.— Between the attachment of the proboscis in the region of the brain and the external opening on the snout is a narrow canal, the rhynchodaeum. In most Hoplonemertea, as described on page 23, the esophagus opens into this canal. It is lined with ciliated epithelium, and in certain species of CARINELLA (Text-fig. 2) its anterior portion contains abundant, deeply staining compound glands much like those of the integument. In the hoplonemerteans and heteronemerteans there is a single layer of columnar ciliated cells without glands.

Proboscis sheath.— The proboscis is attached to the tissues of the head on all sides, so that the cavity of the proboscis sheath, the rhynchocoel, is entirely closed from the exterior, and probably has no communication whatever with any of the other cavities of the body.

The rhynchocoel is usually considerably shorter than the body, although in certain genera of hoplonemerteans it reaches the extreme posterior end. In CEREBRATULUS and some other heteronemerteans it is very nearly as long. In other representatives of each of the three principal orders (CARINELLA, EMPLECTONEMA, and TAENIOSOMA, for example) it is scarcely more than one third as long as the body. In *Carinella frenata*, and less conspicuously in several other species of this genus, the proboscis sheath enlarges in the nephridial region to form a chamber of considerable size (Text-fig. 5) in which the greater portion of the proboscis is coiled. Posterior to this chamber the proboscis sheath contracts into a narrow tube (*rc*) which passes back for a short distance into the intestinal region, and here the retractor muscle of the proboscis is attached. The enlarged chamber also continues posteriorly for a short distance as a blind sac (*rc′*) situated ventrally to the tube in which the proboscis is inserted. In this region therefore a transverse section of the body cuts through both portions of the proboscis sheath. When the proboscis sheath is well developed, the greater part of the proboscis is commonly coiled in its anterior third, the posterior portion being filled mainly with the rhynchocoel fluid.

Only in the genus DREPANOPHORUS are there any appendages to the rhynchocoel, which in this case has paired, tube-like diverticula throughout the greater part of its length. These are metamerically arranged, the pairs of diverticula corresponding in the intestinal region with the pairs of intestinal pouches, which they border dor-

sally, laterally, and ventrally, each diverticulum often extending on the ventral side of the intestinal lobe well toward the median line. These diverticula have a special musculature, and although they are commonly narrow and tube-like, can doubtless enlarge so as to contain a considerable portion of the fluid of the rhynchocoel.

The walls of the proboscis sheath are composed of one or more layers of strong muscles (Pl. 7, fig. 56) lined internally by a flattened epithelium, or more properly endothelium, very much like that of the blood vessels. The endothelium rests on a thick basement layer of homogeneous connective tissue, and in many species of CEREBRATULUS, and in some other forms, contains a considerable number of gland cells. These glands are commonly arranged in irregular rows, situated near the rhynchocoel vessels, and pour their secretions into the rhynchocoel. The endothelium is also modified in the vicinity of the dorsal vessel, becoming more columnar and partially specialized into gland cells.

There are commonly three layers of muscles — outer longitudinal, circular, and inner longitudinal — but in many forms these layers are not very distinct. In DREPANOPHORUS and certain species of AMPHIPORUS there are no distinct layers of muscles in the middle and posterior portions, the musculature consisting of a network of interwoven circular and longitudinal fibers.

In those Paleonemertea which possess an inner circular muscular layer in the body wall, this layer is sometimes closely bound up with the circular muscles of the proboscis sheath, as described for CARINOMA (Pl. 13, figs. 81, 82).

In many species of CARINELLA the longitudinal muscles are almost entirely lacking, except ventrally, so that a single layer of circular fibers constitutes almost the entire muscular wall. As a rule the middle portions of the proboscis sheath are thicker than those either in front or behind.

Rhynchocoel fluid.— The cavity of the rhynchocoel is filled with a fluid plasma in which float numerous corpuscles somewhat resembling those of the blood, although they are much larger. Each corpuscle is commonly oval and discoid, although there is much irregularity in shape (Pl. 23, fig. 164). Some are irregularly spindle-shaped and others spheroidal, but all have the power of amoeboid movement and may be seen to form numerous slender pseudopodia from time to time. Several forms may occur in the same individual. Sometimes

small reddish or yellowish bodies of irregular shape and without nuclei also occur. Each corpuscle has a small oval or spheroidal nucleus, eccentrically placed. The stroma of the cell is usually colorless or very pale greenish, and in some cases encloses fine globules of a reddish or yellowish color.

Bürger ('**91**, p. 484) found in these cells a distinct attraction sphere with one or two centrioles, and his observations have been confirmed by Böhmig ('**98**).

The corpuscles often collect in rather large balls which float to and fro with the movements of the proboscis sheath. In some forms the corpuscles are so numerous as to give the appearance of a compact tissue in the microscopic preparations. Some of the smaller corpuscles resemble the cells lining the proboscis sheath in the vicinity of the dorsal blood vessel, and from these cells they are thought to originate. The fluid itself is usually colorless, although in PARANEMERTES it has a pale reddish color. The corpuscles themselves are colorless in most species, but occasionally, as in *Amphiporus flavescens*, are tinged with yellow or red.

Proboscis.

The proboscis in a large proportion of the nemerteans is provided with one or more very highly specialized stylets usually constituting a formidable armature. Such an armature occurs in all members of the Hoplonemertea except PELAGONEMERTES. This order thus practically corresponds with Max Schultze's order Enopla. The members of the other orders are destitute of such an armature and constitute the order Anopla.

In all forms the highly developed muscular walls are lined externally with a thin endothelium, bathed in the fluid of the rhynchocoel, and internally by a very thick glandular epithelium.

A. **Paleonemertea and Heteronemertea.** — Most of the Paleonemertea are characterized by a comparatively short proboscis and proboscis sheath, but this peculiarity is shared also by TAENIOSOMA. Most of the Lineidae, on the other hand, have the proboscis at least as long as the body, and in some forms it is twice as long, being coiled up in the anterior portions of the rhynchocoel.

Broad and thick species of CEREBRATULUS have a correspondingly thick proboscis, while in slender forms of LINEUS this organ is very long and delicate.

In Carinomella the proboscis is provided with a bulb-like expansion near its anterior end (Pl. 5, figs. 47, 49). The organ is thus divided into three chambers, as in the Hoplonemertea.

In the Paleonemertea and in Taeniosoma the proboscis is provided with two very strong layers of muscles, while most of the Lineidae have three such layers. In the Paleonemertea the outer layer consists of longitudinal muscles, and the inner of circular fibers

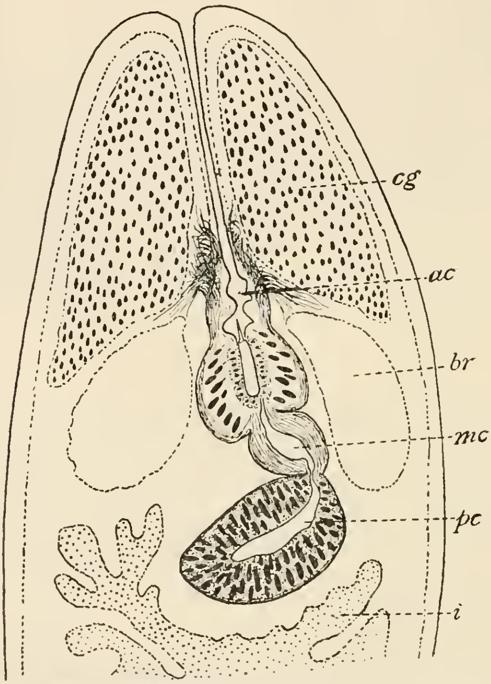

Fig. 9.— *Carcinonemertes epialti.* Horizontal section through anterior portion of body, showing position and extent of proboscis; *ac*, *mc*, *pc*, anterior, middle and posterior chambers of proboscis respectively; *cg*, cephalic glands; *i*, intestinal caecum.

(Pl. 12, fig. 80). In Taeniosoma the order is reversed, the outer layer being circular and the inner longitudinal. In the Lineidae there is an inner and an outer layer of longitudinal fibers with a circular layer between, just as in the muscular layers of the body walls. In a number of species of the Lineidae (*Lineus rubescens* and *L. flavescens*, for example) the inner longitudinal layer is largely or completely wanting.

The circular muscles are as a rule much thinner than the longitudinal layer or layers (Pl. **12**, fig. 80), and in some forms (as CEPHALOTHRIX) are but little developed. In most of the Lineidae the circular muscular layer sends off strands of fibers dorsally and ventrally, which pass obliquely through the outer longitudinal muscles to form a very thin outer layer of circular fibers immediately beneath the outer endothelium. In doing this the strands from the right side cross those from the left in the midst of the longitudinal muscles to form the characteristic dorsal and ventral muscular crosses. These are situated at an angle of 90° with the pair of nerves.

In these orders the proboscis is provided with a single pair of nerves situated right and left (Pl. **12**, fig. 80) in a position corresponding to that of the lateral nerves of the body. They lie directly beneath the inner epithelium except in such of the Lineidae as have an inner longitudinal muscular layer, in which case they are situated just outside this layer. They always branch profusely, and in the Lineidae form so complete a plexus that the two main nerve cords are not to be recognized except in the anterior portion of their course.

The outer surface of the muscular layers is covered by a thin layer of flattened endothelial cells which are bathed in the fluid of the rhynchocoel and rest upon a delicate basement layer (Pl. **11**, figs. 66–71), while the inner surface of the muscles supports a very thick and highly specialized epithelium. The anterior portion of the proboscis in CARINOMELLA (Pl. **11**, fig. 67) is provided with a very thick basement layer, which farther back assumes a position between the longitudinal and the circular musculatures (Pl. **11**, fig. 67), as described in the account of the species.

This epithelium consists almost wholly of various kinds of gland cells (Pl. **11**, figs. 66, 67) from which mucus and other very viscid fluids are secreted, as well as various kinds of rhabdites (Pl. **11**, fig. 72), and, in many Lineidae, urticating filaments. It is thrown up into prominent papillae covered with high pyramidal cells. A description of these cells and of the rhabdites occurs in the specific discussion of *Carinomella lactea*.

When urticating cells are present each cell contains a number of capsules each with a coiled urticating filament several times as long as the capsule itself. Such cells often occur in two longitudinal bands on opposite sides of the proboscis. The extremely viscid secretion of certain of the cells excellently serves the purpose of grasping prey.

The posterior portion of the proboscis is comparatively thin and is destitute of papillae. Here only a viscid mucus is secreted.

The epithelial lining of the proboscis is continuous with that of the rhynchodaeum and like the latter is ectodermic in origin. The musculature is derived from the mesoderm, and in most cases is attached on all sides to the tissues of the head in the brain region. In Carinomella, however, the longitudinal muscles arise from two thick strands (Pl. 6, fig. 54, *emp.*) which are inserted in the tissues of the head immediately anterior to the brain.

B. **Hoplonemertea.** — In this order the proboscis is more highly specialized than in the other orders, and is (except in

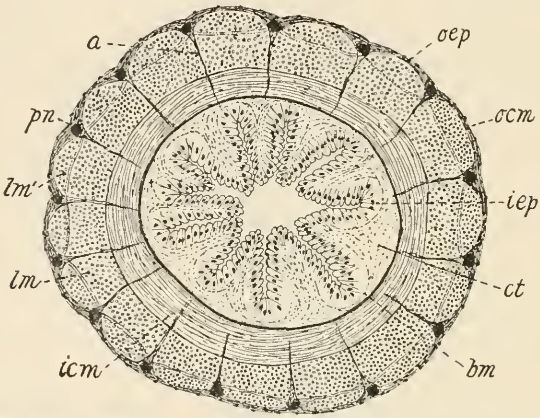

Fig. 10.—*Amphiporus bimaculatus.* Transverse section of proboscis, showing sharply defined proboscis nerves (*pn*); *a*, fibrous dissepiments passing through longitudinal (*lm* and *lm'*) and inner circular (*icm*) muscles.

Pelagonemertes) provided with a highly developed armature, consisting of one or more acutely pointed central stylets and (except in Carcinonemertes) with at least two pouches of accessory stylets.

The proboscis is made up of three chambers. The most anterior of these is lined with highly columnar, glandular epithelium, which is thrown up into prominent papillae. This chamber constitutes by far the major portion of the proboscis and is followed by a short, bulb-like middle chamber lined with a single layer of columnar cells. The posterior chamber is slender, lined with glandular columnar epithelium which secretes a viscid mucus, but which is not thrown up into papillae.

The muscular walls consist of an outer and an inner layer of circular muscles, between which is a much thicker layer of longitudinal fibers (Text-fig. 10). The inner circular layer disappears posteriorly. The middle chamber is constricted off from both anterior and posterior chambers by strong sphincters of circular fibers.

The proboscis is provided with a considerable number of distinct nerves which are situated at equal intervals near the periphery of the longitudinal muscles (Text-fig. 10). In TETRASTEMMA there are usually 10 such nerves, in AMPHIPORUS 10 to 20 or more, while in

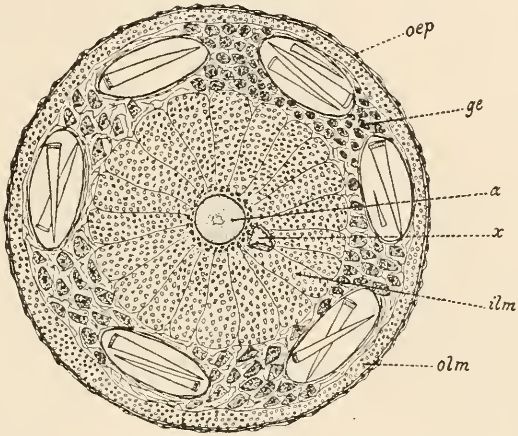

FIG. 11.—*Paranemertes californica.* Transverse section of proboscis through basis of central stylet, showing the six pouches of accessory stylets symmetrically arranged between outer and inner longitudinal muscular layers (*olm* and *ilm*). Space between stylet pouches closely packed with large gland cells (*gl*) filled with deeply staining secretion. Section of basis of central stylet (*a*) in center of proboscis, surrounded by the radially disposed bundles of inner longitudinal muscles. To the right of this a section of the duct (*x*) leading from middle to anterior chamber of proboscis.

DREPANOPHORUS there are 14 to 30 or more, the number being fairly, although not absolutely, constant in each species. These are described on page 53.

It is in the thick muscular septum between the anterior and middle chambers that the specialized armature is situated (Text-figs. 7, 9, 11). An extremely narrow canal leads through this septum and connects the anterior with the middle chamber. In AMPHIPORUS the septum is comparatively thin (Pl. **18**, fig. 115), while in EMPLECTONEMA (Pl. **17**, fig. 107) it is a number of times as thick as the

width of the proboscis, and much thicker than the length of the middle chamber.

There is great variation in the shape and size of the central stylet and in the number of pouches of accessory stylets, and these peculiarities are so well marked and constant that they are of much importance in specific diagnoses.

In all save the members of a single genus (Drepanophorus) there is a single needle-like or conical central stylet imbedded in the apex of a conical, bell-shaped or bullet-shaped basis (Pl. **16**, figs. 94, 96, 98, 100). The whole much resembles an awl with its handle, and is situated in the center of the anterior border of the septum, projecting forward into the cavity of the anterior chamber (Text-figs. 7, 8, 12, 13, 32–34, 36–42, 47, 48, 50; Pl. **17**, fig. 107; Pl. **18**, fig. 115; Pl. **23**, fig. 175; Pl. **24**, fig. 194; Pl. **25**, figs. 200, 201).

The size of the central stylet and basis varies enormously in different species even of the same genus, and often bears little relation to the size of the worm. As a rule, however, the smaller species have a more minute stylet apparatus than do those of larger size. Thus, in small species of Tetrastemma the basis may not exceed one twentieth of a millimeter in length, and is therefore visible only with considerable magnification. The largest basis yet discovered occurs in *Amphiporus macracanthus* (Pl. **24**, fig. 193; Pl. **25**, fig. 200) where the basis alone is about a millimeter in length and easily visible to the unaided eye. In this species the basis is approximately one eighteenth as long as the whole body of the worm when contracted.

The stylet apparatus increases in size with the growth of the individual. In embryos of *Geonemertes agricola*, for example, when they are ready to leave the parent's body, the basis is no more than one four-hundredth the volume of that in a full grown individual, the comparative diameters being as one to ten and the lengths as one to four or five.

The basis is granular and often opaque in its posterior portions. It is closely surrounded by a sheath of closely placed gland cells which form a mold into which their secretions are poured. These secretions harden and form a basis of the exact size and shape of the mold. Other large glands form a wreath near the periphery of the septum, their ducts leading directly to the anterior chamber of the

proboscis (Text-figs. 7, 8, 11). These glands are usually very granular and opaque.

The stylet itself is more or less transparent and glassy, with a central core of more granular nature, which stains readily with ordinary reagents.

In all genera except CARCINONEMERTES there are also at least two pouches of accessory stylets in addition to the central stylet and its basis. These pouches open by narrow canals into the anterior proboscis chamber immediately in front of the septum (Pl. **17**, fig. 107;

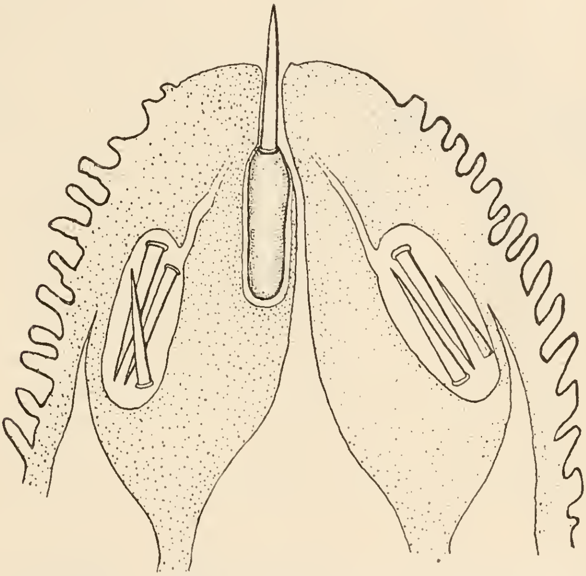

FIG. 12.—*Amphiporus cruentatus*. Optical section of stylet apparatus of proboscis after extrusion.

Pl. **18**, fig. 115; Pl. **23**, fig. 175; Pl. **24**, fig. 194; Pl. **25**, figs. 200, 201). These stylets are, when fully formed, exact counterparts of the central stylet. In most species the stylets are perfectly smooth and evenly pointed, although in *Emplectonema purpuratum* they are fluted (Pl. **17**, figs. 107, 108; Pl. **22**, figs. 159, 160), and in *Paranemertes peregrina* (Pl. **16**, fig. 96) they are grooved spirally. In a few species, as *Emplectonema gracile*, both central and accessory stylets are curved like a saber (Text-fig. 32).

There are commonly but two of these pouches, each containing usually one to three stylets each, although in *A. imparispinosus* there are three pouches, in *A. bimaculatus* either two or four, and in *Paranemertes californica* (Text-figs. 11, 41) four or six, while *A. formidabilis* has eight or twelve such pouches (Pl. 17, fig. 102; Text-fig. 13). In some forms also there may be five to seven or more stylets in each pouch. Usually at least one of the stylets in each pouch is in process of formation and is surrounded by an oval vesicle of clear fluid. The central stylet, on the other hand, is never found in an immature condition, so that it has been thought that the stylets are formed only in the accessory pouches. Here, according to Bürger, each pouch represents a single cell in which the stylets apparently form as concretions in the same way that numerous rhabdites are formed in a single cell. In CARCINONEMERTES, however, where accessory stylets are wanting, it is certain that the central stylet is formed *in situ*, and the development of this structure in GEONEMERTES strongly indicates that it is quite independent of the accessory stylets. It is very doubtful whether the central stylet can, if injured, be replaced by an accessory stylet. It seems far more probable that the central stylet has no genetic relation with any of the accessory stylets.

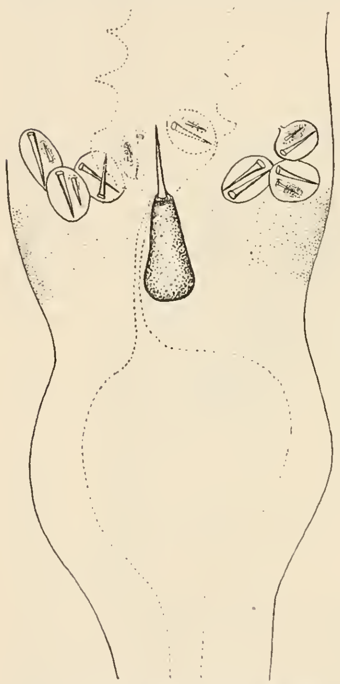

FIG. 13.—*Amphiporus formidabilis.* Outline of stylet apparatus of proboscis, with eight pouches of accessory stylets.

In DREPANOPHORUS the armature consists of a long, sickle-shaped basis on which are imbedded upwards of 15 to 20 minute, top-shaped stylets. There are also about the same number of pouches containing accessory stylets of similar form. The total number of such accessory stylets may amount to upward of 200 in certain species of the genus.

C. **Bdellonemertea.**—In this order the proboscis is similar in general structure to that of the Hoplonemertea, although a stylet apparatus is not present. There is, however, a bulb-like expansion near the posterior end of the organ, between the glandular chamber and the retractor muscle. This bulb is thought to represent a rudimentary condition of the middle chamber and stylet apparatus of the Hoplonemertea.

Blood Vascular System.

A. **Paleonemertea.**—The simplest type of circulatory system occurs in Cephalothrix, where the blood circulates in two main longitudinal lateral vessels, without branches, united at the anterior and posterior ends of the body. These are situated in the body parenchyma beside and somewhat beneath the alimentary canal. In Carinella the lateral vessels unite to form large communicating lacunae in the head. In many species there is a single very large cephalic lacuna, more or less interrupted and broken up into smaller chambers by fibrous partitions, and these lacunae surround the rhynchodaeum on all sides. There is also a pair of rhynchocoel vessels which originate from the lateral vessels in the mouth region then pierce the wall of the proboscis sheath and extend backward for some distance in the cavity of the rhynchocoel, where they appear as ridges in the ventro-lateral walls of the sheath. They exhibit numerous regularly arranged communications with the lateral vessels which they commonly join a little anterior to the nephridial region. A pair of small esophageal vessels is sometimes found in this genus, and in *C. albocincta* the lateral vessels send off numerous anastomosing branches about the esophagus.

In Carinomella, as in Carinella, there are large anastomosing blood lacunae in the head (Pl. 6, fig. 53) and a single pair of lateral vessels (Pl. 7, figs. 55, 56) which send outgrowths into the proboscis sheath. The lateral vessels are large and thin walled in the esophageal region and lie internal to the inner circular muscular layer (Pl. 6, fig. 54), but pass outside this muscle anterior to the nephridial region (Pl. 7, figs. 55, 56), very much as in *Carinella linearis*. Shortly behind the nephridial region the lateral vessels acquire muscular walls and are strongly contracted at intervals. In the intestinal region (Pl. 9, fig. 59) they lie beside the intestine and beneath the sexual glands.

In Carinoma there is a pair of large dorso lateral vessels (Pl. 13, figs. 81, 82) in addition to those found in Carinella. These originate from the lateral vessels in the mouth region and extend to the nephridial region in the parenchyma beside the proboscis sheath. They join the lateral vessels in or near the nephridial region. The rhynchocoel vessels (Pl. 13, fig. 81, *rcv*) are usually very conspicuous. In this genus there are also metamerically arranged transverse vessels in the posterior portion of the body which unite the lateral vessels above the intestine at regular intervals.

B. **Hoplonemertea.** — In this order there is a single dorsal or dorso-median vessel in addition to the pair of lateral vessels. The dorsal vessel arises from a union of the lateral vessels in the brain region and usually passes directly through the walls of the proboscis sheath. It then continues as a ridge on the floor of the rhynchocoel for a short distance, back of which it passes ventrally through the wall of the proboscis sheath beneath which it continues to the posterior end of the body. In some species of Geonemertes and Tetrastemma the dorsal vessel does not enter the proboscis sheath. The pair of cephalic vessels extend forward from the union of the lateral vessels in the brain region and unite at their anterior ends (Pl. 1, fig. 13).

There are also metamerically arranged transverse vessels connecting the three longitudinal vessels above the intestine in the middle and posterior portions of the body. A pair of such transverse vessels lies above and lateral to each pair of intestinal lobes, and therefore, as a rule, alternate with the genital pouches. In Pelagonemertes the dorsal vessel is wanting.

The vessels described are entirely without branches in many hoplonemerteans, although in a number of forms from the Pacific coast (*Amphiporus nebulosus* and *A. gelatinosus*, for example) the lateral vessels undoubtedly branch repeatedly in the anterior esophageal region. Previously it has been generally stated (see Bürger '95, p. 291) that such branches do not occur in any of the Hoplonemertea as here defined.

C. **Bdellonemertea.**—In Malacobdella the three longitudinal vessels branch profusely, their ramifications frequently anastomosing and penetrating all parts of the parenchyma and musculature. No other nemerteans exhibit so complex a network of anastomosing lacunae and tubules, which unite beneath as well as above the ali-

mentary canal. The system has been studied in detail by von Kennel ('78), Takakura ('97), and Maclaren (:01).

D. **Heteronemertea.**— In this order the three longitudinal vessels of the hoplonemertean are always present, and branch freely, forming numerous anastomoses and large lacunae. There are also esophageal and dorso-lateral vessels present in the esophageal region in many forms, and in some species of CEREBRATULUS rhynchocoel vessels likewise occur. The lateral vessels are usually very large in the esophageal region and lie in the angle between the esophagus and the proboscis sheath, but become of smaller size in the intestinal region and are situated ventrally, often approaching medially nearly to the axial line.

The dorsal vessel arises from a broad anastomosis of the lateral vessels (usually dilated to broad lacunae) in the brain region, passes into the rhynchocoel, as in the Hoplonemertea, and remains in this cavity throughout nearly or quite the entire length of the esophageal region, behind which it lies beneath the proboscis sheath. It has metameric anastomoses with the lateral vessels, as in the Hoplonemertea.

The cephalic vessels dilate to form very large lacunae, united anteriorly, surrounding the rhynchodaeum. Occasionally they are represented by numerous anastomosing vessels of small size. The lateral vessels, or lacunae, cover the medial faces of the brain lobes and surround the cerebral sense organs on all sides except anteriorly.

The esophageal vessels often branch profusely, and are often indistinguishable from ramifications of the similarly branching lateral vessels. Both sets of tubules may enter into close contact with the fine branches of the nephridial system.

The rhynchocoel vessels when present are similar to those of CARINELLA and are limited to the esophageal region.

In those forms having a caudal cirrus (ZYGEUPOLIA, MICRURA, MICRELLA, CEREBRATULUS) the lateral vessels continue into this organ, sometimes forming a single large central blood space (Text-fig. 4).

Histological structure.—The blood vessels consist of a rather thick and firm basement layer thrown up into conspicuous ridges when contracted, lined internally with a very thin endothelium with minute oval nuclei, and surrounded by a layer of extremely fine circular muscular fibers. Outside the muscular layer, where the vessel is

imbedded in parenchyma, occurs a layer of large columnar parenchyma cells with large nuclei. Several layers of similar cells often occur around the dorsal vessel when inside the rhynchocoel. The transverse vessels and many of the lacunae are without muscular walls, and even where muscles occur the circulation of the blood is dependent mainly on the movements of the body as a whole, and as a rule passes backward and forward irregularly in any of the vessels. In Stichostemma and Geonemertes large and deeply staining cells occur at intervals just external to the lining of the vessels. Böhmig ('**98**), suggests that these cells project into the lumen of the blood vessel and thus direct the course of the flow of blood. Further evidence, however, indicates that they are merely gland cells which pour their secretion into the blood vessels.

The blood itself consists of a colorless plasma in which float numerous corpuscles. These are usually oval in outline, but much flattened and disc-like. Others are more nearly circular discs, and some spheroidal or somewhat irregular in shape, but as a rule they do not show amoeboid movements.

In certain species (*Tetrastemma bicolor*, *T. signifer*, *T. nigrifrons*, *Amphiporus cruentatus*, and *A. pulcher*) the corpuscles are oval and discoid and of a homogeneous red color, so that they very closely resemble the red blood corpuscles of the frog. Each corpuscle is provided with an oval or spheroidal nucleus of moderate size. This is commonly situated somewhat eccentrically (Pl. **14**, fig. 86). In certain forms granules of pigment or vacuoles of secretion may also occur. In Euborlasia the corpuscles have fine red dots scattered through a greenish stroma. In nearly all species, however, the corpuscles are colorless, although they may have a greenish or orange tinge in certain forms.

Nephridial System.

The excretory organs of the nemerteans consist usually of a single pair of long, branched tubules, situated in close proximity to the lateral blood vessels, and having one or more openings to the exterior on each lateral surface of the body (Pl. **7**, fig. 56; Pl. **8**, fig. 57; Pl. **13**, fig. 82; Pl. **14**, figs. 83–85; Pl. **15**, figs. 91, 92; Pl. **19**, fig. 120).

In the majority of forms the nephridia are limited to the esophageal region, and usually extend through but a small portion of the

distance from mouth to intestine. In the elongated forms of CARINELLA, TAENIOSOMA, LINEUS, and other genera these excretory organs may be less than one twentieth as long as the body, but in other forms (NEMERTOPSIS, STICHOSTEMMA, and GEONEMERTES, for example) they extend throughout practically the whole length of the body. Probably in no case is there any direct communication between the nephridia and any other vessels — the only openings to the canals being the pores by which they discharge their contents on the surface of the body, or, in rare instances into the alimentary canal. In the majority of forms there is but a single such excretory pore on each side of the body, but in other species there may be as many as 20 or more. Where numerous efferent ducts are present, the number increases with the size and probably with the age of the individual. In STICHOSTEMMA Böhmig ('98) found but a single pair of nephridia in small individuals while the larger specimens invariably had several.

A. **Paleonemertea.**— In most species of CARINELLA, CARINO-

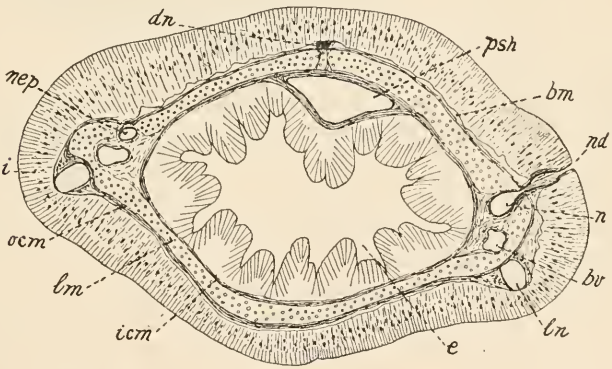

FIG. 14.—*Carinella rubra.* Transverse section of body in nephridial region, showing position of nephridia (*nep*), and opening of efferent nephridial duct (*nd*); *e*, stomach ; *ln*, lateral nerve ; *bv*, lateral blood vessel.

MELLA, and CARINOMA the nephridium of each side consists of a rather broad canal situated in the posterior half of the esophageal region. This canal becomes narrow towards its anterior third (Pl. 5, fig. 48), and lies close against the lateral border of the thin-walled lateral blood vessel. From the side of the canal very numerous short processes or finger-like projections push out directly against the wall of

the blood vessel, pressing in its walls at the point of contact, so that the short processes of the nephridial canal project freely into the lumen of the blood vessel, thus forming the so-called nephridial gland (Pl. **14**, figs. 84, 85). In this way the lumen of the blood space is greatly decreased, and at the same time the very numerous finger-like projections bring a vast surface of the nephridial canal into contact with the blood contained in the lateral vessels (Pl. **15**, fig. 92).

The posterior two thirds of the nephridial canal is large and smooth and entirely without branches. In *Carinoma mutabilis* the tube passes backward for some distance in the parenchyma near the lateral vessels, then bends forward for a short distance, and ends in a narrow efferent duct which passes through the muscular layers of the body wall to open by a small excretory pore situated on the dorso-lateral surface of the body (Pl. **14**, fig. 84).

In *Carinella sexlineata*, as described in this paper, and in other species of the genus, the relations are similar, the main canal on each side passing forward from the efferent duct quite to the region of the "nephridial gland" without branches. Here it sends off several branches which subdivide into the finger-like processes in the wall of the adjacent lateral blood vessel, as described above. In *C. rubra* the efferent ducts connect with the main canal by a broad, sieve-like funnel (Text-fig. 14) which projects into the widened lumen of the canal. In *C. albocincta* there are 5 to 8 longitudinal canals on each side, and these do not join until near the efferent duct, where they unite to form a rather large lacuna from which the efferent duct passes to the exterior.

In Carinella and Carinomella the pair of excretory pores lie in the vicinity of the lateral sense organs (Pl. **15**, fig. 91).

B. **Hoplonemertea.**— In this order the nephridial canals branch profusely in the body parenchyma, and these branches lie in close proximity to the lateral blood vessels. Bürger (**'91**) describes the branches of the nephridia in Drepanophorus as twining about the lateral blood vessels very much as a vine twines about a tree. Each of the small branches terminates in a small chamber in which swings a tuft of long cilia.

In many hoplonemerteans the branches extend all through the parenchyma on each side of the body, a portion of them lying at the side of the proboscis sheath far removed from the lateral vessels, as in *A. gelatinosus* (Pl. **19**, fig. 120).

In this order there is commonly but a single pair of efferent ducts and these pass dorsally to the lateral nerves and then bend sharply downward to open on the ventro-lateral aspects of the body. In *A. imparispinosus* there are commonly 6 to 8 or more efferent ducts on each side, and in *A. formidabilis* often more than 20. Not all of them open ventrally, however, for in the latter species nearly all open on the dorsal side of the body (Text-fig. 15) and in the former those ducts situated most anteriorly open ventrally, while those

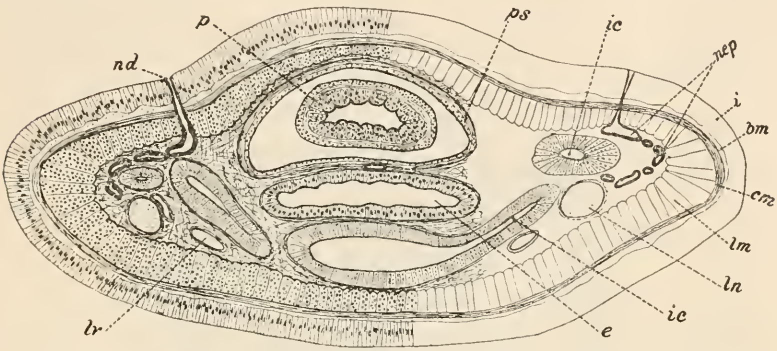

FIG. 15.— *Amphiporus formidabilis.* Transverse section through nephridial region, showing efferent nephridial duct (*nd*) opening dorsally. Four sections of branched intestinal caecum (*ic*) are indicated *e*, pylorus; *lv*, lateral blood vessel.

farther back open dorsally. In *Tetrastemma quadrilineatum* the nephridia are situated in the brain region, and the pair of efferent ducts open on the lateral margins of the head in the vicinity of the dorsal ganglia. In *T. reticulatum* they are situated but little farther posteriorly.

In STICHOSTEMMA and GEONEMERTES the nephridia extend the whole length of the body, and there are numerous efferent ducts, a portion of which open above, and others beneath, the lateral nerves (Montgomery, '95, and Böhmig, '98).

C. **Bdellonemertea.**— In MALACOBDELLA the nephridia form a complex system of branching canals which penetrate the parenchyma in all directions. The single pair of nephridiopores is situated in *M. grossa* on the ventral side of the body and in *M. japonica* on the dorsal side.

D. **Heteronemertea.**— In this order the nephridia are usually richly branched, and the tubules often lie side by side with the

branches of the lateral blood vessels, which ramify in all directions beside and beneath the esophagus. In some species of CEREBRATULUS there is a most profuse branching of both sets of tubules in the middle esophageal region, the fine nephridial canals winding in and out among the blood vessels, and being intimately associated with them. In several species of MICRURA the nephridial canals branch out close against the lateral wall of the large lateral blood vessel which lies in the angle between the proboscis sheath and the esophagus.

In some forms the nephridial tubules extend the whole length of the esophagus and stomach and are provided with numerous ducts on each side. In all species of the order the excretory pores are situated above the lateral nerves, and in *Micrura verrilli* are sometimes not far removed from the median line. The efferent ducts when numerous are disposed without regularity, and although there may be approximately the same number on each side yet they are by no means in regular pairs.

The nephridial canals are lined with a single layer of columnar epithelium which rests on a homogeneous basement membrane. The epithelium is comparatively thin in the smaller tubules but is very high in the larger canals and in the efferent ducts. These cells are provided with delicate, rather short cilia sparsely scattered over the free surface. In many forms, especially the hoplonemerteans, the fine branches probably end in slightly enlarged terminal vesicles, in each of which a tuft of long cilia is suspended. Such terminal vesicles are described in detail by Bürger ('91).

In a few forms (CEPHALOTHRIX, PROSADENOPORUS, and PELAGONEMERTES) the nephridia have not been discovered as yet. In *Paranemertes californica* the efferent ducts are very inconspicuous so that I was unable to find their openings. In *Taeniosoma melanogrammum* (*T. quinquelineatum*) Punnett (:00, p. 116) describes some of the efferent ducts as opening into the alimentary canal. In a recent study of *Taeniosoma unilineatum* from the Hawaiian Islands I have found an exactly similar condition — from 7 to 20 efferent ducts on each side opening directly into the lumen of the esophagus, while a smaller number of perfectly similar ducts opened on the dorso-lateral surface of the body. There are also a few other cases where the nephridia do not conform to the types described above.

Nervous System.

Central nervous system. — In many of the smaller translucent species of AMPHIPORUS, TETRASTEMMA, and other hoplonemerteans the form and position of the brain, sense organs, and principal nerves can be studied in life, but in the vast majority of forms recourse must be had to methyl blue preparations or serial sections. In many species the brain and lateral nerves are light red or yellowish in color when living.

In the head of all nemerteans a four lobed brain constitutes the

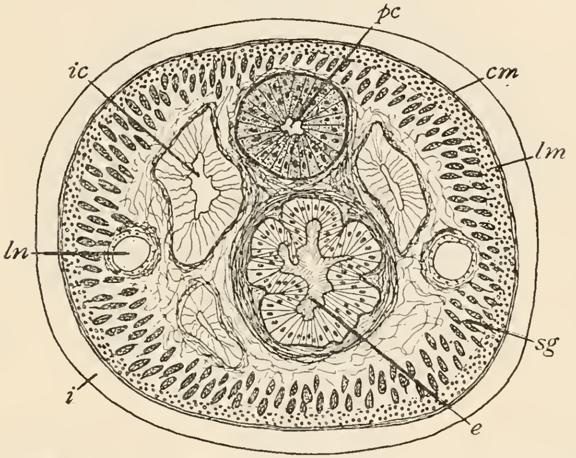

FIG. 16.— *Carcinonemertes epialti.* Transverse section of body immediately back of brain, showing posterior chamber of proboscis (*pc*) firmly imbedded in surrounding connective tissue; *ic*, intestinal caecum; *sg*, submuscular glands.

most highly specialized nervous center, and from this brain a pair of lateral nerves extend to the posterior end of the body, where they usually unite with each other above the end of the alimentary canal.

The position of the brain and lateral nerves with respect to the layers of the body walls is very different in the various orders, and forms one of the most important taxonomic features. In PROCARININA and CARININA the brain lies completely in the integument, while in CARINELLA and most other paleonemerteans it lies immediately beneath the basement layer of the integument.

In the Hoplonemertea the brain lies imbedded in the body paren-

chyma entirely internal to the musculature of the head (Text-fig. 19; Pl. **19**, fig. 119) and in the Heteronemertea it also lies mainly internal to the cephalic musculature by which it is closely surrounded.

In all nemerteans the four lobed brain consists of two ganglionic masses on each side — the dorsal and ventral ganglia. The anterior ends of the dorsal ganglia of the two sides are united above the anterior end of the rhynchocoel by the dorsal commissure, while a considerably stronger ventral commissure unites the ventral ganglia in a corresponding position beneath the rhynchocoel (Text-figs. 3, 19; Pl. **16**, figs. 93, 95, 97, 99).

In most Paleonemertea the dorsal ganglia are larger than the ventral, while in the other orders the ventral ganglia are the larger. The apparent size of the dorsal ganglia in the Heteronemertea, however, is usually greatly increased by a close fusion with the cerebral sense organs which commonly assume the appearance of posterior lobes of this portion of the brain. Here the dorsal ganglia are bilobed posteriorly, the dorsal lobe ending blindly, while the ventral continues directly into the sense organ.

As a rule the proboscis is attached to the wall of its sheath in the immediate vicinity of the brain commissures. The blood vessels connecting the cephalic blood spaces with the vessels of the rest of the body also pass between the dorsal and ventral commissures. In the Hoplonemertea the esophagus lies immediately beneath the ventral commissure (Text-figs. 3, 19; Pl. **19**, fig. 119).

The position of the lateral nerves with respect to the layers of the body walls is even more variable than that of the brain. In Carinina and Procarinina these nerve cords lie wholly in the integument; in Carinella they are situated between the basement layer and the outer circular muscles; in Carinoma they lie outside the circular muscles anteriorly, but when as far back as the posterior end of the esophageal region pass through these muscles and take up a position throughout the rest of the body in the midst of the longitudinal muscular layer (Pl. **13**, figs. 81, 82). In Carinomella a condition intermediate between that found in Carinella and that in Carinoma occurs, for in Carinomella the lateral nerves lie outside the outer circular muscles anteriorly, but more posteriorly they sink inward among the fibers of the longitudinal muscles, although they still carry beneath them a portion of the circular muscular fibers (Pl. **8**, fig. 58; Pl. **9**, fig.

60). In Cephalothrix they are situated in the midst of the longitudinal muscles throughout the whole length of the body.

In the Heteronemertea the nerve cords lie immediately outside the circular muscles and beneath a greatly thickened outer longitudinal muscular layer, while in the Hoplonemertea they occupy positions quite internal to the musculature of the body walls and are surrounded by the body parenchyma (Text-figs. 16, 17).

In nearly all nemerteans the lateral nerves are situated well toward the lateral margins of the body, although in Drepano-

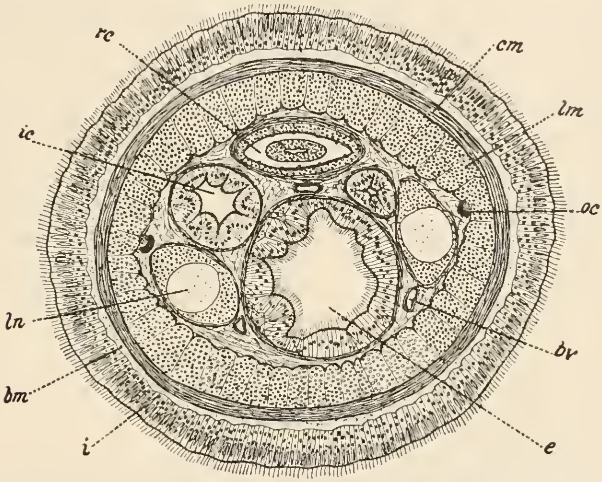

Fig. 17.—*Zygonemertes thalassina.* Transverse section of body immediately back of brain, showing intestinal caeca (*ic*) reaching forward to abut against dorsal ganglia. Ocelli (*oc*) extend back of brain, and occupy positions, as shown, immediately above and external to lateral nerve.

phorus they lie comparatively near together toward the ventral surface of the body.

In general histological structure the brain and lateral nerves are closely similar, although each has nerve cells of a somewhat different character. Each has a central core of very delicate fibrils of connective tissue in which slender nerve fibers are imbedded. The central core is surrounded by a delicate sheath of connective tissue, outside of which the massive layer of nerve cells is situated. An outer sheath of connective tissue covers this peripheral layer of nerve cells.

Three or four more or less distinct varieties of nerve cells can be distinguished. Bürger ('95), Montgomery ('97[b]), and others have described these different kinds of nerve cells in great detail. They are: (*a*) unipolar, naked cells of small size, with deeply staining oval nuclei; (*b*) slender, pear-shaped, somewhat larger cells, often arranged radially about the fibrous core; (*c*) much larger, flask-shaped or retort-shaped cells in which the cell body stains almost as deeply as the nucleus, and which are commonly situated more peripherally than the clusters of the other two varieties; each of the cells of this last variety is enclosed in a delicate sheath of connective tissue. All the nerve cells, but especially those of the first two varieties are arranged in groups or masses, and their delicate processes unite in bundles before entering the fibrous core.

In addition to these three types of cells a fourth variety is found in certain heteronemerteans and in a few hoplonemerteans. These are very much larger than any of the other types of nerve cells and their processes are so very large that they resemble the neurochords of annelids. There are often one to three pairs of these neurochord cells in the ventral ganglia, and many more pairs in the lateral nerves. In such cases the processes of all usually unite into a single bundle.

In some nemerteans a few delicate muscular fibers pass longitudinally in the substance of the lateral nerves between the fibrous core and the outer sheath of connective tissue.

Peripheral nervous system. — In addition to the brain and pair of lateral nerves nearly all species of nemerteans are provided with *dorsal*, *esophageal*, *proboscidial*, and *cephalic nerves*, together with nerves to cerebral sense organs and numerous branches from the lateral nerves to adjacent muscles, sense organs of integument, etc. Many paleonemerteans have also a ventral nerve, corresponding in position to that in the dorso-median line, but situated ventrally.

Nervous layers in body walls. — All except the Hoplonemertea have one, or sometimes two, nervous layers in the body walls, formed by anastomosing fibers from the lateral nerves. In the Heteronemertea this plexus lies between the circular and outer longitudinal muscular layers, and consists of a cylindrical nervous plexus extending nearly the whole length of the body. A secondary nervous plexus may lie immediately internal to the circular muscles. This is formed of branches passing through the circular muscles from the outer nervous layer.

In CARINELLA and other paleonemerteans a delicate nervous plexus lies between the basement membrane and outer circular muscular layer. In HUBRECHTIA this plexus becomes very massive.

In all cases the nervous layers consist of very delicate nerve fibrils and a few small nerve cells supported by a delicate framework of connective tissue.

Dorsal nerves. — In all nemerteans a dorsal nerve (Pl. **7**, figs. 55, 56), usually situated immediately outside the circular muscles, arises from the dorsal brain commissure and extends in the median line throughout the whole length of the body.

An inner dorsal nerve, situated internal to the circular muscles and above the proboscis sheath, occurs in many forms (Pl. **7**, fig. 55). This nerve usually arises from branches from the outer, or principal, dorsal nerve, and does not originate from the brain directly. It innervates the proboscis sheath.

Ventral nerve. — In CARINOMA, CARINOMELLA, and certain other paleonemerteans a distinct ventral nerve is situated in the median line immediately external to the inner circular muscles of the body walls in the esophageal region (Pl. **7**, figs. 55, 56; Pl. **13**, fig. 82). In the anterior portion of the body this nerve may lie external to the outer circular muscles (Pl. **13**, fig. 81). It apparently arises from the nervous plexus above mentioned, and its development is correlated with increase in size of the inner muscles.

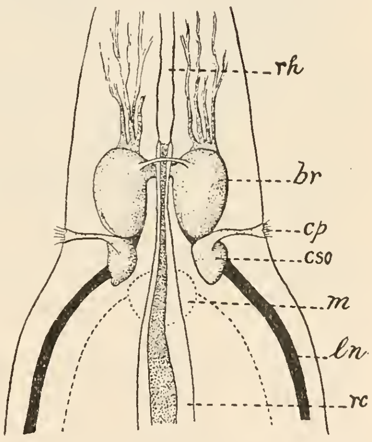

FIG. 18.—*Zygeupolia littoralis.* Diagram of anterior portion of body, showing cephalic nerves and relation of cerebral sense organ (*cso*) to ciliated pit (*cp*) on side of head; *rh*, rhynchodaeum; *br*, brain; *ln*, lateral nerve; *m*, mouth. *After* C. B. Thompson.

Cephalic nerves.— The ocelli and other sense organs of the head are supplied with numerous conspicuous nerves. In most species these cephalic nerves arise from the anterior faces of the dorsal ganglia, although in some forms (Text-fig. 18) they are supplemented by similar branches from the ventral brain lobes.

The presence of remarkably large and numerous cephalic nerves in CARINELLA (Text-fig. 2) and CARINOMELLA (Pl. 6, fig. 53), although ocelli are wanting, indicates the presence of abundant cephalic sense organs.

In many hoplonemerteans three to five pairs of large and profusely branching cephalic nerves supplying the ocelli and other organs of the head can often be distinguished in life. These arise from the anterior border of the dorsal ganglia.

Esophageal nerves. — In all nemerteans in which the mouth is situated behind the brain (Paleo- and Heteronemertea), a pair of nerves originate from the ventral ganglia and supply the mouth region and anterior portions of the esophagus (Pl. 15, fig. 90). After their origin these nerves are commonly connected with each other by one or more (sometimes numerous) commissures, and often have secondary unions with the ventral ganglia. They end in fine branches a short distance behind the mouth, and supply the epithelium of the buccal cavity and anterior end of esophagus.

Proboscidial nerves. — The proboscis in all Paleo- and Heteronemertea is provided with a single pair of large nerves which are situated on the right and left sides of the organ and extend throughout its whole length. They usually arise from the ventral commissure near the ganglia, and enter the proboscis at its insertion among the tissues of the head in the region of the brain commissures.

In the Paleonemertea they take up a position immediately between the inner epithelial lining and the musculature (Pl. 12, fig. 80; Pl. 11, figs. 66–70; Pl. 15, fig. 90). Here they send out branches to form a more or less conspicuous plexus, but do not branch out so much as to lose their identity.

In those Heteronemertea in which only two muscular layers are developed in the proboscis (most Taeniosomidae and certain Lineidae) the nerves take a position, as in the Paleonemertea, beneath the inner epithelium, but in all those forms in which the proboscis is provided with three muscular layers the nerves lie between the inner longitudinal and the circular muscles. In all these forms the nerves send out very numerous branches which spread out into a conspicuous nervous plexus. In some species, moreover, this distribution of the nerve fibers into the plexus is so complete that the nerve cords can no longer be recognized. This is particularly the case in the Taeniosomidae.

In the Hoplonemertea the number of proboscis nerves varies greatly in different species of the same genus, but is fairly constant for all individuals of the same species. Thus *Amphiporus similis* and *A. macracanthus* have each 10 proboscis nerves; *A. flavescens* and *A. californicus* 10, 11 or 12; *A. punctatulus* 12 or 13; *A. bimaculatus* 14 or 16; *A. nebulosus* 17; and *A. angulatus* 17 to 20,

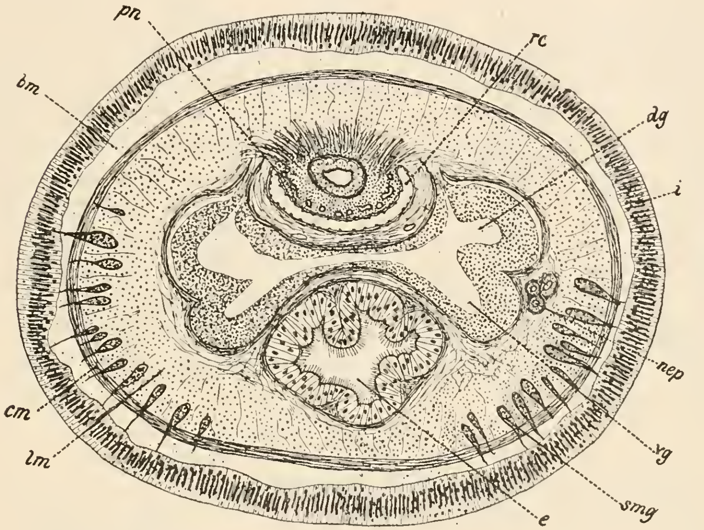

FIG. 19.—*Amphiporus angulatus.* Transverse section through ventral commissure of brain, showing dorsal attachment of proboscis to tissues of head. Anterior ends of nephridial tubules (*nep*) appear in right half of section; *smg*, submuscular glands; *pn*, proboscidial nerves.

but usually 18. Nearly all species of TETRASTEMMA have 10 proboscidial nerves, while some forms of DREPANOPHORUS have more than 30.

In many hoplonemerteans all the proboscis nerves originate directly from the anterior border of the brain, although in *A. angulatus* (Text-fig. 19) and some other forms those arising from each side of the brain are at first more or less fused into a single trunk which breaks up into a definite number of independent nerves after reaching the proboscis.

In all hoplonemerteans the nerves lie imbedded in the midst of the longitudinal muscular layer in the portion of the proboscis

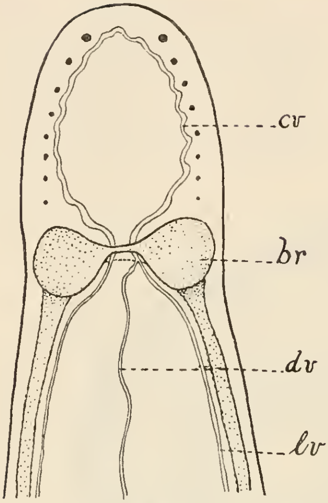

FIG. 20.— *Amphiporus cruentatus.* Outline of anterior portion of body, showing position of ocelli and relation of cephalic (*cv*) to lateral (*lv*) blood vessels.

anterior to the stylet region, and remain almost perfectly constant in number and position (Text-fig. 10). In the stylet region, however, they fuse into an irregular nerve plexus. Sometimes this nerve plexus is double, and its inner portion supplies the stylet apparatus, while its outer portion continues backward beneath the epithelium of the middle proboscis chamber. In the region of the proboscis behind the middle chamber the nerves are in some species again arranged into their definite number of nerve cords, and these again become situated in the longitudinal muscles, but their size is very insignificant as compared with that of the corresponding nerves of the anterior chamber.

Sense Organs.

In addition to the sensory epithelium found in the integument in all regions of the body all nemerteans possess certain highly specialized sense organs. Such sense organs include ocelli, oblique and horizontal cephalic grooves or furrows, cerebral, lateral and frontal sense organs, while the members of a single genus (CARINOMA) have a row of sensory pits on the dorsal surface of the head, and those of another genus (OTOTYPHLONEMERTES) possess otoliths.

Ocelli.— Eyes are wanting in all the Paleonemertea except CEPHALOTHRIX and HUBRECHTIA, but are generally present in the Hoplonemertea and in the majority of species, including nearly all genera, of the Heteronemertea. In

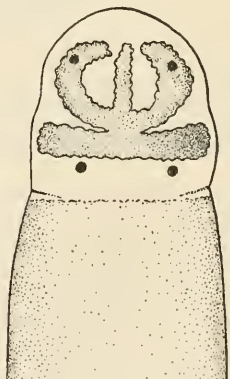

FIG. 21.— *Tetrastemma signifer.* Outline of anterior portion of body, showing position of ocelli and shape of cephalic marking.

most species of hoplonemerteans the ocelli are very highly specialized, and are often sufficiently large to be seen with the unaided eye. They are often numerous, and are of fairly constant number in different specimens of equal size of the same species, but different members of the genus have a widely different number of ocelli. *Amphiporus bioculatus*, for example, has but a single pair, while some individuals of *A. formidabilis* (Text-fig. 23; Pl. **17**, fig. 101), have upward of 250, and in several species of the same genus ocelli are entirely wanting. When ocelli are numerous they increase rapidly in number during the growth of the individual (as in *A. imparispinosus*). In Drepanophorus (Text-fig. 22; Pl. **24**, fig. 181) the ocelli reach their highest development, each ocellus consisting of a complete visual apparatus including lens, pigment cells, retina, and optic nerve.

In Tetrastemma 4 ocelli are usually present, and these are arranged on the head at the corners of a square or rectangle (Text-fig. 21; Pl. **2**, figs. 17, 18, 25; Pl. **17**, fig. 104; Pl. **18**, fig. 113; Pl. **22**, figs. 145, 146). In *T. aberrans*, however, the ocelli are much fragmented (Pl. **24**, fig. 150), while in *T. caecum* they are entirely wanting.

In the Pacific coast species of Amphiporus the smallest number of ocelli in mature individuals of any species is 8, while in another form (*A. formidabilis*) as many as 250 may be present. The average number in the 17 species from this region in which the ocelli have been accurately observed is approximately 40, and this is about the average number in species from other parts of the world. When few in number they may be arranged in a single row on each margin of the head, as in *A. cruentatus* (Text-figs. 20, 51; Pl. **1**, fig. 13), but when very numerous are usually distributed in two or more elongated clusters on each side (Text-figs. 23, 46, 53; Pl. **16**, figs. 93, 95, 97, 99; Pl. **17**, fig. 101; Pl. **18**, fig. 117; Pl. **22**, figs. 154, 157; Pl. **23**, figs. 162, 163; Pl. **25**, figs. 195–199).

Emplectonema has very numerous, but minute, ocelli; Zygonemertes has upward of 50, several of which are scattered in a single row along the lateral nerves for some distance behind the brain (Pl. **22**, fig. 141; Pl. **24**, fig. 182). In *Paranemertes californica* there is but a single pair of minute ocelli, while the other three species of the genus have a considerable number (Pl. **23**, fig. 177; Pl. **24**, fig. 190; Pl. **25**, figs. 198, 199). In Nemertopsis there are 4 eyes of

large size (Pl. 11, fig. 73), and in Carcinonemertes but a single pair (Pl. 2, fig. 20). In Planktonemertes and Malacobdella ocelli are wanting.

In the Heteronemertea ocelli are usually present in great numbers, but of small size in Taeniosoma, are wanting in Zygeupolia, Parapolia, Oxypolia, Euborlasia, and Diplopleura, while their presence in Lineus, Micrura, and Cerebratulus is to be regarded as a specific distinction only. On the Pacific coast, ocelli are wanting in four species of Lineus and present in four; in Micrura five species have ocelli, while only two known species have none; in Cerebratulus likewise five species possess ocelli, which are wanting in two other species of the genus from that region.

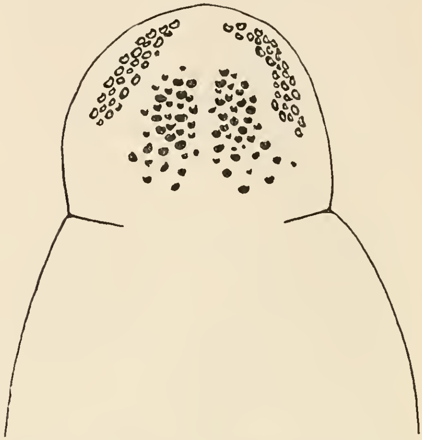

Fig. 22.—*Drepanophorus ritteri*. Outline of anterior portion of body, showing number and position of ocelli. Marginal groups strictly belong to ventral surface but show through overlying tissues when head is compressed.

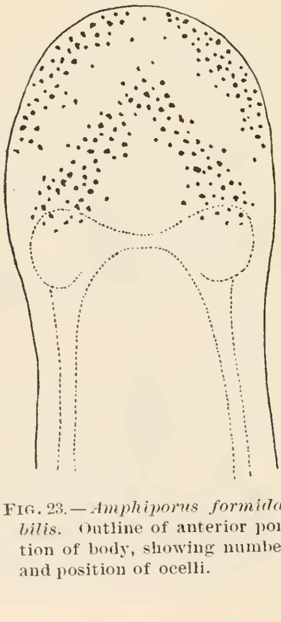

Fig. 23.—*Amphiporus formidabilis*. Outline of anterior portion of body, showing number and position of ocelli.

Cephalic grooves and furrows.—Carinella, Carinomella and certain other paleonemerteans have a pair of lateral transverse grooves just back of the head lined with slightly differentiated epithelium which is doubtless of a more sensory nature than that of the rest of the integument. Nearly all hoplonemerteans have one or two pairs of lateral oblique grooves of which the anterior pair lies in front of brain. These grooves are often nearly semicircular, the two grooves of the pair coming near together and passing obliquely

backward toward the median line on the dorsal surface (Pl. **18**, figs. 111–113), but are commonly more widely separated beneath. When most highly specialized, as in DREPANOPHORUS and *Amphiporus bimaculatus* (Pl. **18**, figs. 116, 117), the grooves are conspicuous because of the fluted appearance caused by numerous transverse ridges. They are largely devoid of gland cells and pigment, and are lined with slender sensory cells with long cilia.

Among the Heteronemertea TAENIOSOMA often has somewhat similar oblique, but less highly specialized grooves, while at least one species (*T. hemprichi*) of the genus has an indication of the highly developed horizontal furrows of most of the Lineidae. In these grooves the canals leading to the cerebral sense organs terminate.

In the Lineidae the horizontal furrows are best developed, although certain members of the family have them merely indicated or completely wanting. When well developed they are situated on the exact lateral borders of the head, and commonly extend from the tip of the snout back to the brain or as far as the anterior border of the mouth. The cerebral sense organs always connect by means of a ciliated canal with the posterior ends of these furrows, which are shallow anteriorly and deepest at their posterior ends. In CEREBRATULUS they are usually much deeper than in LINEUS, and in some species cut into the tissues of the head as far as the lateral borders of the brain. In *C. coloratus* Bürger, however, they are represented merely by slight grooves, and in other Lineidae, as ZYGEUPOLIA (Text-fig. 18), they are wanting completely, the canals from the cerebral sense organs opening into slight pits on the lateral borders of the head.

Among the Pacific coast forms *Micrura alaskensis* and *Cerebratulus nebulosus* are peculiar in having very shallow cephalic furrows, while in most other Lineidae from that region they cut inward well toward the brain. In most species their length is considerably greater than the transverse diameter of the body, but in *C. latus* (Pl. **4**, fig. 41), which is a remarkably short and broad form, they are not more than one seventh as long as the greatest diameter of the body. As a rule the furrows are deepest in those forms in which they are longest, but there are certain exceptions. Where the furrows are very long the canals from the cerebral sense organs open somewhat in front of their posterior ends.

The epithelium lining the grooves is often without pigment, although it possesses gland cells, and is characterized by slender, sensory cells with long cilia and by numerous small nerve cells much like some of those of the dorsal brain lobes.

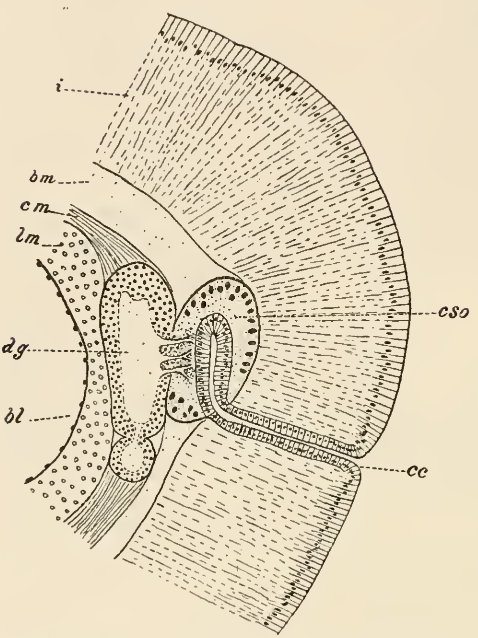

FIG. 24.—*Carinella rubra.* Portion of transverse section through brain region, showing highly specialized cerebral sense organ (*cso*) and its relation to the ciliated canal (*cc*) and nerves arising from dorsal ganglion (*dg*).

Cerebral sense organs. — All except a very few nemerteans have a single pair of highly specialized sense organs in the vicinity of the brain. Such sense organs appear to be wanting only in CALLINERA, CARINOMELLA, CARINOMA, CEPHALOTHRIX, MALACOBDELLA, CARCINONEMERTES, and PELAGONEMERTES. In CARININA, and in certain species of CARINELLA they consist of simple sensory pits on the sides of the head, but in all other forms in which they are present, they are specialized as more or less spherical organs usually situated internal to the body walls and connected with the exterior by means of a ciliated canal.

In the Paleo- and Hoplonemertea they are connected with the dorsal ganglia by large nerves, while in the Heteronemertea they form large posterior lobes of the dorsal ganglia.

In *Carinella albocincta* and *C. sexlineata* (Pl. 15, fig. 90) they are little developed, consisting simply of a pair of sensory pits in the integument just lateral to the dorsal ganglia with which they are connected by several large nerves, but in *C. rubra* they form spheri-

cal organs surrounded by connective tissue, and are situated beneath the integument. In the center of the sense organ (Text-fig. 24) lies a ciliated canal lined with sensory epithelium and gland cells. This canal passes to the surface of the integument, and opens to the exterior of the body, sometimes at the summit of a small papilla situated at the bottom of a conspicuous pit on the side of the head, as in *C. frenata* (Text-fig. 25). The central cavity of the sense organ is thus freely connected with the water outside the body, so that the cells of the sensory epithelium of the canal can respond to stimuli conducted to them through the water. The definite function of the sense organs, however, still remains an unsolved problem. In *C. frenata* the ciliated canal penetrates the basement membrane and extends inward to the dorsal side of the brain (Text-fig. 25). Several large nerves pass from the dorsal ganglion directly into the substance of the sense organ (Text-figs. 24, 25).

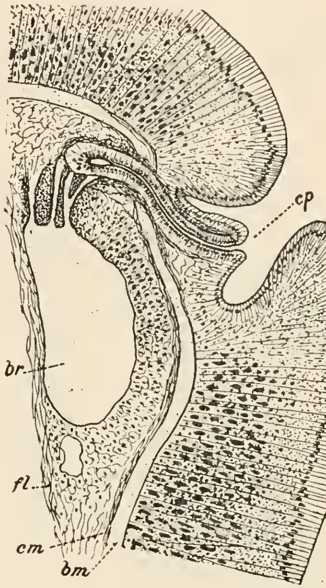

FIG. 25.—*Carinella frenata.* Portion of transverse section of head, showing deep, ciliated pit (*cp*) from which a ciliated sensory canal leads inward to brain region, where it becomes surrounded with sensory nerves from dorsal side of brain to form a highly specialized sense organ.

In its more highly specialized condition, as in the Heteronemertea, the canal of the sense organ presents two more or less distinct segments marked off by the entrance of the ducts from large clusters of gland cells. The external section of the canal extends from the exterior of the body to the anterior glandular cells of the sense organ, and is characterized by slender cells with very long cilia. The internal, or posterior, section extends posteriorly from the anterior glandular masses and is peculiar in having a very highly specialized epithelium on its lateral face, while its internal face is lined with slender, ciliated cells much like those of the anterior section.

The posterior section usually passes backward near the lateral face of the sense organ, then bends medially to conform with the curvature of the organ, and finally rises somewhat, bends a little forward, and then ends blindly.

The sensory epithelium lining the lateral face of this section of the canal is very greatly modified, and consists of two lateral rows of very large cells, often with more than a single nucleus each, and each provided with a stiff process formed of a tuft of consolidated cilia. Between the two rows of lateral cells are four rows of smaller, so-called median cells all of which possess consolidated cilia somewhat similar to those of the lateral cells. All the cells of these six rows are very highly specialized, and doubtless have an important sensory function, the nature of which is not yet understood. The other cells lining this section are similar to those of the anterior portion of the canal.

Two large masses of gland cells discharge their secretions into the lumen of the canal. One of these clusters discharges at the point separating the anterior from the posterior section, as stated above, while the other pours in its secretions some distance farther back.

In the Hoplonemertea the sense organs are situated either in front, beside, or behind the brain. Those situated most anteriorly, as in Emplectonema, are comparatively small, while those lying beside or behind the brain, as in Drepanophorus (Pl. **24**, fig. 181) and some species of Amphiporus (Pl. **21**, fig. 129), are much larger. There is actually much variation in size, position, and structure in different species of the same genus. Of the 19 species of Amphiporus from the Pacific coast in which the position of the sense organ is known, 13 species have these organs situated in front of the brain, while in the other 6 species they lie beside the brain, in the angle between the dorsal and ventral ganglia, and in some of these project some little distance posterior to brain.

In the Hoplonemertea the anterior end of the posterior section of the canal often divides into two distinct tubes, one of which swells out into a sac-like sensory enlargement occupying the main portion of the organ, while the other continues behind the main portion as a long, coiled glandular tube which ends blindly posteriorly.

The sensory portions of the canal are surrounded with very numerous nerve cells much like those of the dorsal ganglia with which they are more or less continuous in the Heteronemertea. In

this order the dorsal ganglia are bilobed posteriorly, the ventral lobe with its large fibrous core continuing directly into the sense organ. This projects freely into the large lateral blood lacuna, with which it is completely surrounded except on its anterior face.

Lateral sense organs.— These occur in a well developed condition only in the Paleonemertea, although similar organs, but much less highly specialized, are found in MICRELLA (Punnett, :01[b]) and perhaps also in ZYGEUPOLIA (Thompson, :02, p. 686). When most highly specialized (Text-fig. 26) they are oval or circular areas of modified sensory epithelium provided with a special musculature and capable of considerable movement. They can be raised as elevations above the surrounding integument or depressed as pits. A single pair of these sense organs lie on the lateral margins of the body in the immediate vicinity of the nephridiopores. In CARINELLA (Text-fig. 26; Pl. 15, fig. 91), CARINOMELLA (Pl. 7, fig. 56) and most other paleonemerteans, the sense organs are very highly developed. They are provided with branches from the adjacent lateral nerves, are free from pigment, and usually have numerous gland cells. The sensory cells are very slender, closely packed, and provided with long cilia. For details of structure see the specific description of *Carinomella lactea.*

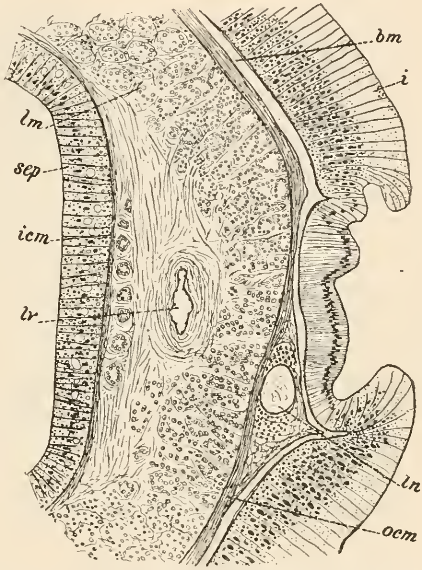

FIG. 26.— *Carinella frenata.* Portion of transverse section of body through lateral sense organ, showing single layer of specialized sensory cells lining sensory pit; *ln*, lateral nerve; *bm*, basement membrane.

Frontal sense organs.— At the tip of the snout and immediately dorsal to the proboscis pore occur, in many of the Heteronemertea, one to three circular pits lined with epithelium of a highly sensory nature. In CEREBRATULUS and MICRURA there are often three such

pits, and in several related genera but a single one. In some cases the ducts from the cephalic glands enter an apparently homologous pit, as in TAENIOSOMA, GEONEMERTES, and other genera of both the higher orders. In such cases this frontal pit often becomes very deep, and may penetrate the tissues of the head back nearly to the brain region (GEONEMERTES). It not only serves as a duct for the secretions of the cephalic glands, but retains a specialized sensory epithelium.

Cephalic sensory pits.— In *Carinoma mutabilis*, as well as in *C. tremaphoros* (Thompson, :00, p. 627) and *C. armandi* (Bergendal, :03, p. 610, and :04, p. 44), a number of small sensory pits are situated in the median line on the dorsal surface of the head. They are apparently homologous with the frontal sense organs and frontal pits of many of the Heteronemertea and Hoplonemertea, as described above. Their function is doubtless similar to that of the cerebral sense organs in other Paleonemertea. Their number is usually from 6 to 12, and they are placed at irregular intervals between the brain and the tip of the snout. In structure each sense organ consists of a small cup, or hollow sphere, of sensory cells situated at the base of the integument and closely pressed against the underlying basement membrane.

These sense organs may open widely at the surface or become well separated from it, according to the state of contraction of the parts. In the latter case they are connected with the exterior by narrow canals. The sensory cells are provided with long cilia and are apparently connected with the brain by one or more nerves from the dorsal commissure. In *C. tremaphoros* and in *C. armandi* such sense organs are comparatively well developed, while in *C. mutabilis* they are so very inconspicuous that they were overlooked in my original description.

They appear to be provided with special muscular fibers, and can doubtless be opened and closed to some extent by the muscular contractions, much as is the case with the lateral sense organs.

Reproductive Organs.

All the nemerteans as yet known from the Pacific coast, with the exception of *Tetrastemma caecum*, which is probably parasitic, and the fresh water STICHOSTEMMA, are of separate sexes. Very few

hermaphroditic species are known from other parts of the world, and all of these belong to the Hoplonemertea.

The sexual glands are always of simple structure, each gland consisting merely of a sac of sexual products situated in the parenchyma between the alimentary canal and the body musculature.

The sexual glands are usually limited to the intestinal region, although in the parasitic CARCINONEMERTES (Coe, :**02**, p. 448) they

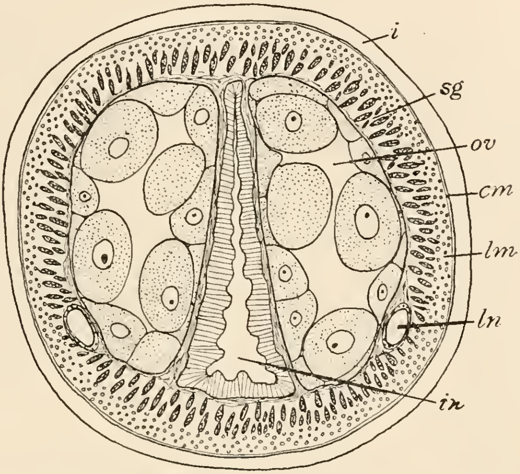

FIG. 27.—*Carcinonemertes epialti.* Transverse section of body, showing thick layer of submuscular glands (*sg*), ovaries (*ov*) with large ova, and intestine (*in*) reduced to a narrow canal.

extend forward nearly to the brain. In *Emplectonema bürgeri* and *Amphiporus occidentalis* they extend forward far in front of the opening of the pylorus into the intestine.

Where metameric intestinal lobes are found the sexual glands, as a rule, alternate with them with great regularity. In comparatively few cases is there more than one gland between two adjacent intestinal lobes.

In the parasitic CARCINONEMERTES, however, the intestinal lobes are much reduced and the body packed so full of sexual glands that as many as 5 to 8 ovaries (Text-fig. 27) or 7 to 15 spermaries (Text-fig. 28) may be encountered in a single transverse section of the body. In some species of TETRASTEMMA and other minute hoplonemerteans the eggs are of comparatively large size (Pl. **22**, fig.

151), so that each ovary contains but a single ovum, and this is often separated from the next by several intestinal lobes. In *Emplectonema bürgeri* as many as 20 to 30 spermaries are sometimes met with in a single section. The anterior ones are situated dorsally and open on the dorsal aspect of the body, while those found in the intestinal region lie on all sides of the alimentary canal and open to the exterior on the ventral as well as on the dorsal side of the body. This is equally true of *Paranemertes peregrina* and *P. carnea.*

In Carinella and Carinomella the sexual glands when fully mature are packed closely together throughout the whole intestinal region, and a transverse section of the body may cut several such sacs on each side. Each sac has its own efferent duct, which passes through the body walls to open to the exterior on the dorso-lateral aspect of the body. The sexual glands occupy the dorsal half of the body, and as some lie much nearer the lateral margin than others it happens that their ducts, instead of being placed in a single row, are scattered over a broad area situated between the median line and the lateral margin. The genital pores of many nemerteans can be seen in life as minute white dots along the dorso-lateral aspects of the body. They are quite conspicuous in *Micrura verrilli* (Pl. 3, fig. 35).

In most species of Carinella the sexual glands are not to be found except at the time when the sexual products are developing, and after these products are discharged all trace of the gland itself disappears. In *C. frenata*, however, the ovaries which are to develop the following year are established before the eggs of one season are fully mature, as is the case in most of the Hoplo- and Heteronemertea.

In process of formation certain cells situated in the parenchyma internal to the lateral nerves multiply and collect in small groups. Each such group grows rapidly in size and in the number of cells composing it. Then certain of these cells arrange themselves next the parenchyma to form a thin membrane enclosing the other cells as in a cavity. Thus a sexual sac is formed, and the cells within the sac eventually become metamorphosed into the mature sexual elements. When nearly mature the wall of the sac grows outward into the muscular layers of the body wall as a simple tube lined with flattened epithelium (Pl. 10, fig. 63; Pl. 20, figs. 122, 125–127).

This duct does not pierce the outer layers of the body wall until the sexual products are fully mature. These products are discharged by being merely pressed through the efferent ducts, when they fall into the water outside the body. Their discharge is under the control of the animal, however, and under circumstances they may be held in the body for a long time unless the worm receives the necessary stimulus.

A few species, belonging to widely separated genera, are viviparous, the eggs being fertilized within the body.

In CEREBRATULUS, DREPANOPHORUS, certain species of AMPHIPORUS and probably numerous other forms belonging to the higher orders, a small portion of each sexual gland remains after the genital products have been discharged and can be distinguished at all seasons of the year. In these forms the process of development of the sexual products may be followed with comparative ease.

Ovogenesis — As described in the account of *Amphiporus gelatinosus*, the thin-walled follicle remains as a small sac lined with flattened cells immediately after the last sexual elements have been discharged. The gland remains in this condition until the season for the production of the sexual elements. In the case of the female certain of the nuclei then increase rapidly in size and may be distinguished as the germinal vesicles of future ova, while neighboring nuclei become surrounded with yolk spheres (Pl. 20, figs. 125–127). The details of the formation of the yolk-nucleus and the development of the ovum are likewise described for *A. gelatinosus*.

A similar process has been described for CEREBRATULUS by C. B. Wilson (:00, p. 123), and here the position of the stalk of attachment can be distinguished even after the egg leaves the body. The germinal vesicle always occupies the side of the egg opposite the stalk, the polar bodies form in the vicinity of the germinal vesicle, and the plane of the first cleavage extends vertically through both the region of the polar bodies and that of the egg stalk. The egg can thus be definitely oriented even before it leaves the ovary.

Mature eggs are either spherical or somewhat oval, and vary greatly in size, color, opacity and general appearance in different species. They are always provided with a large germinal vesicle which varies from one third to one half the diameter of the egg.

In *Carinella frenata* 20–50 ova develop in each of the closely packed genital sacs. These eggs are opaque and rose colored, giv-

ing the characteristic coloring to the bodies of the females in the breeding season. *Amphiporus tigrinus* has olive green ova, so that the ripe females are banded with green.

In the hermaphroditic *Tetrastemma caecum* the ova are fully two thirds the diameter of the body itself, and hence a single ovum develops in each of the ovaries, which are situated at intervals in a single irregular row (Pl. 22, fig. 151). The spermaries are much more numerous than the ovaries between which they are placed. The spermaries usually develop first, and after the discharge of the spermatozoa the ovaries become mature, but in some individuals the process is apparently reversed.

In *Geonemertes agricola*, which is both hermaphroditic and viviparous, some of the gonads produce ova only or spermatozoa only, while in other gonads both kinds of sexual products may be formed (Coe, :04[a]). In the latter case the spermatozoa are matured first, and after their discharge the ova develop, very much in the manner described by Montgomery ('95) for Stichostemma. Each ovary matures normally but a single ovum, although in the early stages of its development all of the cells of the young gonad seem to be exactly alike in size and appearance. In a short time, however, the cells become differentiated into three classes — young ova, yolk cells and follicular cells. The latter form a thin layer about the wall of the gonad and furnish the cells which form the duct by which the sexual gland is connected with the exterior of the body. This duct is formed comparatively early, and penetrates quite to the exterior before the egg in the gonad has reached maturity. The yolk cells are apparently merely egg cells which for some reason become aborted at an early period. They are rather numerous in each young ovary, and grow to a size several times that of the largest follicular cells. They become crowded with yolk granules and pressed closely against the wall of the developing ovum. To all appearances the cell membranes separating ovum and yolk cells break down and the latter are absorbed directly into the substance of the ovum. The whole substance — cytoplasm, yolk, and nucleus — of the yolk cell seems to be thus absorbed. There may be several large cells in the young ovary which are distinguished from the yolk cells by a more homogeneous cytoplasm. These cells increase rapidly in size and take on the appearance of young ova. Eventually, however, all save one, or rarely two, cease their growth

and become disintegrated to furnish food materials for the single large ovum. Before the maturity of the ovum the oviduct is in free communication with the exterior of the body, and through this duct spermatozoa from another individual gain access to the ovary. Here they may remain alive for some time, one of them fertilizing the ovum at its maturity. The duct to the exterior then closes up and the fertilized ovum begins its development. In the course of several weeks the egg gives rise to a slender, whitish worm fully provided with a delicate proboscis armature and with practically all the organs of the adult except the sexual glands. This worm ruptures the body wall of the adult and gains access to the outer world.

Spermatogenesis.— The details concerned in the process of formation of the spermatozoa have not yet been made fully clear for any species of nemertean. The most complete accounts are those by Lee ('87) and Bürger ('95). In spermaries which are approaching maturity five different elements can be distinguished: (*a*) the follicular cells, (*b*) spermatogonia, (*c*) spermatocytes, and (*d*) spermatids which become transformed into (*e*) ripe spermatozoa.

The follicular cells form the lining of the gonad and the duct by which the mature spermatozoa are discharged. They are similar to those of the ovaries described above. All the other cells are collected into groups in various parts of the gonad, each group containing only one kind of cell.

The last generation of spermatogonia are distinguished by having large, oval nuclei and comparatively little cytoplasm. They divide to form the secondary spermatocytes, which have very sharp nuclei and distinct cell membranes and are naturally considerably smaller than the cells from which they arise. They divide to form the spermatids which collect in similar groups and are distinguished by their small size and the eccentric position of the nuclei. Each spermatid is doubtless transformed into a spermatozoon, although the details of the process have not been fully observed. In certain species a single spermary occupies the space between two adjacent intestinal lobes, while in other forms, as in Gononemertes (Bergendal, :00[a]) and Carcinonemertes (Coe, :02), the number of spermaries may be greatly increased, so that they may occupy the whole circumference of the body internal to the muscular walls (Text-fig. 28).

The mature spermatozoon consists of head, middle-piece and tail, although the differentiation of parts is not always very conspicuous.

The shape of the head varies greatly in different species, being short oval, slender oval, rod-like, conical, needle-like, or even curved and needle-like. Sometimes closely similar species exhibit considerable difference in the shape of the spermatozoa.

Reproduction. — In all except a few species of nemerteans the sexes are separate and the sexual products when mature are discharged through the genital ducts into the water in which the worm lives. In some cases practically all the genital products in the

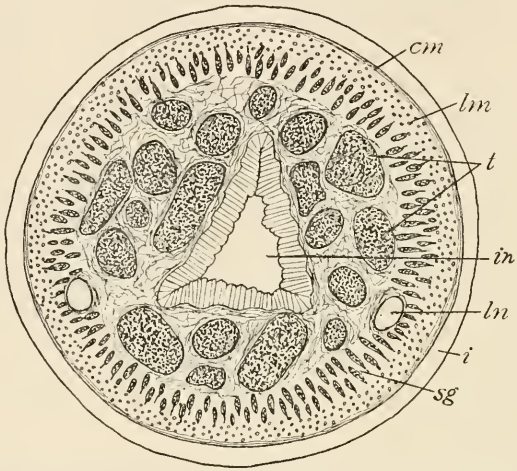

FIG. 28.— *Carcinonemertes epialti.* Transverse section of body showing the large number of spermaries (*t*) and their distribution through body parenchyma.

body are discharged at the same time, while in other forms the deposition of ova or spermatozoa may occur at intervals of a number of days, so that several clusters of eggs or several emissions of spermatozoa may result.

Although in such cases there is no union of the sexes yet the presence of a delicate sexual instinct among the nemerteans is indicated by the observations of McIntosh ('73) and confirmed by those of C. B. Wilson (:00), who found that in *Cerebratulus lacteus* the discharge of ova by a female in one portion of an aquarium was accompanied by the simultaneous emission of spermatozoa by another worm living in another portion of the aquarium.

In many species, especially of the Hoplonemertea, the eggs are deposited in gelatinous masses of secretion beneath the stones or in

the burrows in which the worms live. In such cases two or more individuals of both sexes commonly come together at the time of oviposition.

It is probable that most species of nemerteans are more strongly gregarious in the breeding season than in other portions of the year, for upward of 50 sexually mature individuals of *Micrura alaskensis*, some of which were 300 mm. long, have been found in close contact under a single stone (Coe, :01, p. 74).

In most of the Hoplonemertea comparatively few, but very large eggs are produced, and in some species but a single ovum matures in each gonad. In some cases this ovum is a third as large as the diameter of the body (Geonemertes, Tetrastemma), and in the commensal *Tetrastemma caecum* the few ova produced are about two thirds the diameter of the body. The discharge of such enormous ova must necessarily cause serious rupture of the body walls, although it may not cause the death of the worm. The eggs of *Geonomertes australiensis* are described by Dendy ('93) as being about a third the diameter of the body. Several clusters of such eggs are discharged at intervals of a number of days without apparent permanent injury to the worm.

The viviparous *Geonemertes agricola* gives birth to young worms exceeding in length the diameter of the parent's body, and yet the presence of young ovaries and spermaries indicates that the birth of the young does not cause the death of the parent.

It is probable, however, that many species are more or less regularly annual, living but a single year and perishing after the discharge of the sexual products. Other forms probably live for many years.

Many of the Heteronemertea and some of the Paleonemertea produce an enormous number of eggs of small size, which are discharged free into the water. In the large species of Carinella, Taeniosoma, Micrura, Lineus, Euborlasia, and Cerebratulus the number of eggs produced in a single season is enormous. In *Cerebratulus lacteus*, for example, a medium sized individual, about 5 feet long, has been estimated to produce from fifty thousand to a quarter of a million eggs in a season (Coe, '99[a]). On this basis of calculation how great would be the number produced by an individual, as has been recorded by Verrill, 22 feet long and an inch in width!

Where the number of eggs is so very large, their size is usually only from one sixth to one twelfth of a millimeter in diameter.

An account of the processes of fertilization and development of the egg is given on pages 73–75.

A few species of nemerteans are viviparous, the eggs being fertilized within the body. Here they develop into young worms which at the time of birth are fully provided with all the organs of the adult except the sexual glands. Most of the known viviparous forms belong to PROSORHOCHMUS, although the terrestrial *Geonemertes agricola* (Coe, : 04[a]), one or more species of TETRASTEMMA and STICHOSTEMMA, and a single species of LINEUS (*L. viviparus* Isler) likewise give birth to living young.

In CARCINONEMERTES and STICHOSTEMMA, as well as in *Geonemertes australiensis*, the eggs are often fertilized within the body and are usually deposited shortly after fertilization. In some cases, however, a portion of them may remain in the body until the later stages of cleavage or even until after the formation of free swimming embryos.

In all these forms it seems probable that cross fertilization normally occurs, the spermatozoa passing from the body of one individual into the ovaries of another. This process has been observed for several species, the male lying side by side with the female and the spermatozoa passing from one body to the other through the intervening mucus. The spermatozoa thus reaching the ovaries through the oviducts may remain alive for some days and fertilize the ova as they mature. Dendy ('93) has noticed such spermatozoa in the ovaries of GEONEMERTES, and I have seen them in STICHOSTEMMA. Child (: 01), on the other hand, was led by his observations to the belief that self-fertilization normally occurs in STICHOSTEMMA, for the eggs and spermatozoa ripen in the same gonad at the same time. In *S. graecense* also both kinds of sexual elements mature at the same time (Böhmig, '98), while according to Montgomery ('95) *S. eilhardi* is protandric.

In *Geonemertes agricola* the sexual phases are complicated by the appearance of (*a*) forms with ovaries only, (*b*) individuals with developing embryos, and with immature ovaries or spermaries, or both, and (*c*) purely male forms of small size whose bodies are distended with spermatozoa. The conditions observed in this species (Coe, : 04[a]) may be explained by the hypothesis that at least a por-

tion of the individuals pass through several phases of sexuality, being (*a*) first hermaphroditic and protandric, then (*b*) maturing a brood of large embryos which absorb a large portion of the tissues of the adult, so that it then becomes either (*c*) a smaller sized individual which develops spermatozoa, and is looked upon as a male, or (*d*) matures or absorbs its small spermaries and retains its ovaries so that it again appears as a pure female at the beginning of the following season.

Development.

Since the publication of Bürger's Monograph on the nemerteans of the Gulf of Naples ('95) a number of papers have appeared dealing exclusively with the development of certain species. These papers include accounts of the development and maturation of the sexual cells, the processes of egg-laying, fertilization, cleavage, gastrulation, and the formation and structure of the pilidium in certain Lineidae. The important features of most of these papers have been included in Bürger's comprehensive treatise on the development of the nemerteans in Bronn's Thierreich (vol. 4, supplement, p. 308–384, 1903), and to this important treatise the reader is referred for a critical review of the literature previous to the year 1900.

Embryological studies have been confined mainly to the Lineidae, Amphiporidae, Cephalothrix, and certain viviparous Hoplonemertea, so that at the present time practically nothing is known of the developmental processes in any of the Paleonemertea except Cephalothrix, nor in the Taenisomidae, nor in any save a few species of the Hoplonemertea.

The general course of development is better known in *Lineus viridis* than in any other nemertean, owing to the researches of Desor ('48), Barrois ('77), McIntosh ('73), Hubrecht ('85), and Arnold ('98). In another form which also occurs on the Pacific coast, *Cerebratulus marginatus*, the maturation and fertilization of the egg has been carefully studied by Kostanecki (:02), and by myself ('99). I have also studied the gastrulation of the egg of this species, and the formation of the early pilidium ('99[a]).

Barrois ('77), McIntosh ('73[a]), and myself ('99[a]) have observed the direct development of *Cephalothrix linearis*, and Barrois ('77), and Hoffman ('77) that of *Tetrastemma dorsale*. I have also

observed the direct development of *Zygonemertes virescens* ('99[a]). In no other species as yet known from the Pacific coast has the process of development been studied.

The *direct type* of development occurs in CEPHALOTHRIX and in all of the hoplonemerteans which have been studied embryologically. In these forms the segmentation of the egg results directly in the formation of the body of the nemertean without any intermediate free-swimming stage. The direct type of development has been observed in CEPHALOTHRIX and ZYGONEMERTES, as stated above, in *Carcinonemertes carcinophili* by Barrois ('77), in PROSOROCHMUS by Bürger ('94), in MONOPORA (= PROSOROCHMUS?) by Salensky ('84), in AMPHIPORUS by Barrois ('77), and myself ('99[a]), in DREPANOPHORUS by Barrois ('77), and Lebedinsky ('98), in TETRASTEMMA by Barrois ('77), Hoffman ('77), and Lebedinsky ('98), in STICHOSTEMMA by Child (:01), in MALACOBDELLA by Hoffman ('77[a]), and in GEONEMERTES by Dendy ('93[a]), and by myself (:04[a]).

The most complete general account of the direct type of development is that given by Lebedinsky ('98) for *Tetrastemma vermiculus* and *Drepanophorus spectabilis*. The development of the various organs of the body is described by Salensky ('84) for *Monopora vivipara* (= PROSORHOCHMUS ?), by Bürger ('95) for PROSORHOCHMUS, and by myself (:04[a]) for GEONEMERTES.

The *indirect type* occurs in all the heteronemerteans in which the course of development has been followed, although unfortunately all observations have thus far been confined to the Lineidae. In this type the segmentation of the egg results in the formation of a ciliated embryo, inside which the body of the young worm develops. In *Lineus viridis* the metamorphosis is not very complete, and the larval form is known as Desor's larva. In MICRURA and CEREBRATULUS, on the other hand, an embryo is produced which has no resemblance to the future worm, and which swims actively in the water for a season, and finally by a complicated metamorphosis produces the body of the young worm. The larval, free-swimming form is known as the pilidium (Text-figs. 29, 30) and bears a certain superficial resemblance to the trochophore of annelids. The pilidium occurs in *Lineus* (?) *lacteus* (Metschnikoff, '69), in *Micrura* (Coe, '99[a]), and in *Cerebratulus* (C. B. Wilson, '98, and :00, and Coe, '99[a]).

A brief résumé of the process of fertilization and cleavage of the

egg, and formation of the pilidium of *Cerebratulus marginatus*, which occurs on the Pacific coast, may be given here. The mature egg of this species measures about 0.16 mm. in diameter, with an eccentrically placed germinal vesicle of about one third to two fifths the diameter of the egg. Soon after the egg is discharged into the water its germinal vesicle disappears and the polar spindle is formed with 16 small chromosomes in its equatorial plate. The developmental processes will go no further, however, until after the

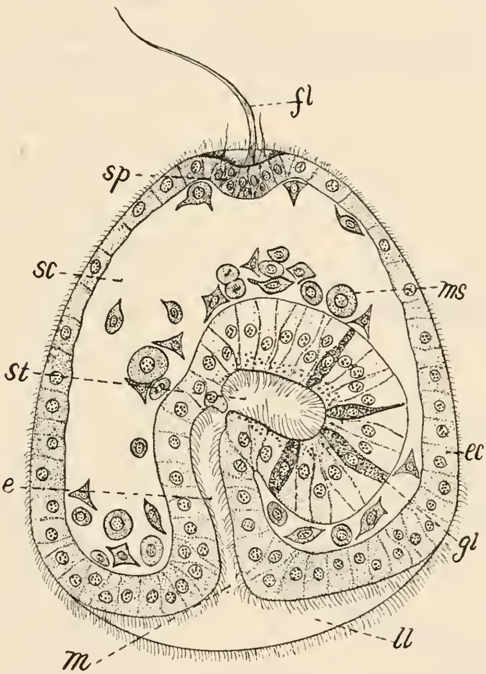

FIG. 29.—*Cerebratulus marginatus*. Median sagittal section of embryo at beginning of pilidium stage; *sp*, apical plate; *fl*, flagellum; *sc*, segmentation cavity; *st*, stomach, showing four deeply stained gland cells (*gl*); *e*, esophagus; *m*, mouth; *ll*, lappet; *ec*, ectoderm; *ms*, mesoderm.

entrance of the spermatozoon, and in eggs which are not fertilized the first polar body is not formed. The spermatozoon may enter the egg at any point, but usually does so at the side of the egg farthest from the eccentrically placed germinal vesicle. The pair of centrosomes and asters form in the immediate vicinity of the sperm

head as in many other invertebrates. The sperm head increases rapidly in size by absorption from the surrounding egg cytoplasm, and its chromatin is rearranged to form a large sperm nucleus. Meanwhile the first polar body is discharged, followed in a few minutes by the second. The chromatin remaining in the egg forms an egg nucleus which fuses with the sperm nucleus. At this time both nuclei are of about the same size. The sperm asters degenerate, their centrosomes disappear, and in their places a pair of minute cleavage asters arise. These enlarge to form the typical cleavage asters with fibers extending throughout the substance of the egg. It is still a matter of doubt as to whether the centrosomes of the sperm asters persist and occupy the centers of the cleavage asters or whether they degenerate, the centrosomes of the cleavage asters being entirely new formations. Kostanecki (:02), however, considers the evidence in favor of the former view as almost conclusive.

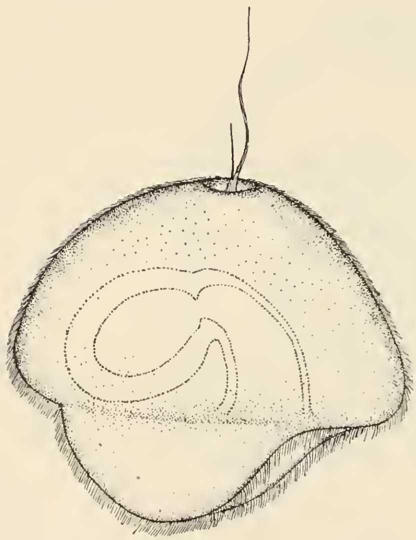

Fig. 30. — *Cerebratulus marginatus.* Pilidium ten days after fertilization of the egg. Digestive tract indicated by dotted lines.

The segmentation of the egg is total and equal as far as the four-celled stage and conforms throughout to the regular spiral type. In the eight-celled stage, however, the four cells of the animal pole are slightly, though distinctly, larger than those of the opposite side of the egg.[1] Such a peculiarity is also characteristic of the eggs of *Cerebratulus lacteus* and *Micrura caeca*, although it is known in no other animals with a spiral type of cleavage.

[1] The details of the process of cleavage and very interesting experiments on the development of egg-fragments, isolated blastomeres, and blastula-fragments are described in a recent paper by E. B. Wilson (:03) for *Cerebratulus lacteus*.

A free-swimming blastula forms in a few hours, and from this the gastrula develops. The invagination apparently involves not only the entoderm but also the neighboring ectoderm cells, so that the primitive enteron which is thus formed consists of two chambers — the broad esophagus, composed of ectodermic cells, leading into the second, smaller chamber, the blind mid gut, or stomach, which is lined with the entoderm (Texts-figs. 29, 30).

In the course of two days the gastrula develops into the pilidium (Text-fig. 30), for the structure of which the reader must be referred to previous papers (Coe, '99[a]; Bürger, '97–:03). The structure of the pilidium of other forms has been studied by Metschnikoff ('69), Salensky ('84), Bürger ('94), Coe ('99[a]), C. B. Wilson (:00), and others.

The complicated metamorphosis by which the body of the young worm develops within the pilidium has been described by Krohn ('58), Leuckart and Pagenstecher ('58), Metschnikoff ('69), Bütschli ('73), Salensky ('86), and Bürger ('94). An excellent account of these processes so far as they are at present known is given by Bürger in Bronn's Thierreich (vol. 4, supplement, p. 338–366).

Geographical Distribution.

The total number of species recorded in this report from the Pacific coast of North America is much larger than was to have been expected, for there are now more species of nemerteans described from this coast than from any other region of equal size on the globe, although as yet comparatively few attempts have been made at their collection. And, as has been noted elsewhere, we find in these localities not only so large a number of species, but also a surprising abundance of individuals of the forms represented. And certainly I know of no region where so large a proportion of the invertebrate animals found in a miscellaneous collection belongs to the nemerteans as on the northwest coast of North America.

The study of these collections has had an increased interest because of its bearing on the geographical distribution of certain of the species represented.

Of the 86 species at present known from the Pacific coast of North America and the coasts of Alaska bordering the Bering Sea and Arctic Ocean, only 10 have as yet been recorded from other

portions of the globe. Of these ten species all except one, *Emplectonema gracile*, which is common in Europe, occur also on the eastern coast of North America. Four species occur on both the eastern and western coasts of North America, but have not yet been found elsewhere. These are *Carinella pellucida*, *Zygonemertes virescens*, *Amphiporus cruentatus*, and *Zygeupolia littoralis*. A single species, *Amphiporus angulatus*, is common to the eastern and western coasts of North America and Greenland, but is not found in Europe; while the remaining four species — *Cephalothrix linearis*, *Tetrastemma dorsale*, *Lineus viridis*, *Cerebratulus marginatus* — occur on both coasts of North America, as well as on the northern coast of Europe, in the Mediterranean Sea, and elsewhere.

The relationship of the Pacific coast nemertean fauna with that of Europe and the Mediterranean is, however, much closer than is indicated by the identity of species alone, for a number of genera are represented in both regions by very similar, though specifically distinct, forms. NEMERTOPSIS and EUBORLASIA are examples of genera having representatives in European waters and on the Pacific coast, but of which no species have as yet been found on the Atlantic coast of North America, or in other parts of the world. Then, too, the close relationship of a number of species from the Pacific coast with corresponding European forms is very striking. Examples of very similar, though specifically distinct, forms are *Carinella rubra* with *C. polymorpha*; *C. sexlineata*, *capistrata*, *albocincta*, and *cingulata* with *C. superba*, *annulata*, and *banyulensis*; *C. pellucida* with *C. linearis*; *Nemertopsis gracilis* with *N. peronea*; several species of AMPHIPORUS; *Tetrastemma bicolor* with *T. vermiculus*; *T. nigrifrons* with *T. melanocephalum*; the hermaphroditic *T. caecum* with *T. kefersteini*, while a similarly close resemblance holds for species of LINEUS, MICRURA, and CEREBRATULUS.

Griffin ('98) considered that the nemerteans of the Pacific coast showed on the whole a closer affinity to those of Europe than to those of the Atlantic coast of North America, and my own impression is that this view is well founded even though the number of specifically identical forms is so small. When collecting nemerteans on the Pacific coast it has been a source of almost constant surprise that the forms collected so closely resembled well-known European species with which they were at first sight thought to be identical, yet when critically studied almost invariably revealed

well marked specific differences either in external characters or in internal anatomy.

On the other hand, while a larger number of species are identical with those on the Atlantic coast, yet the majority of forms are widely distinct both in general appearance and anatomically. The numerous species of Carinella, Emplectonema, Amphiporus, Drepanophorus, Tetrastemma, Taeniosoma, and the strikingly marked species of Lineus and Micrura of the Pacific coast, have few counterparts on the Atlantic coast, although, as stated above, very similar forms occur in Europe. My personal experience at Naples has served to emphasize rather than diminish the importance of this striking similarity of faunas so remote geographically.

A number of investigators have observed that other classes of invertebrates collected in Puget Sound showed a similarly close relationship with those of Europe and the Mediterranean.

Two species (*Lineus viridis* and *Cerebratulus marginatus*) occur in the Mediterranean, on the northern coasts of Europe, on the coasts of Greenland and northeastern America, as well as in Alaska and on the Pacific coast. These are evidently circumpolar forms and their distribution is thereby readily accounted for. *Cephalothrix linearis* and *Tetrastemma dorsale* may also be looked upon as circumpolar species.

One of the most important factors, however, in the distribution of marine organisms, namely, the temperature of the water, is not greatly different on the southern coast of California, where many of the species referred to were collected, than it is in the Mediterranean. So that a Mediterranean species when once established on the Pacific coast, or the reverse, would probably have little difficulty from its environmental conditions.

It may be reasonably expected that future investigations on the coasts of Japan, northern China, the Kurile Islands, Kamchatka, and eastern Siberia will reveal a much more extended distribution of many of the species herein recorded. The few collections which have been made at the Commander Islands, off the coast of Kamchatka, have thus far contained only the same species as those found on the coast of Alaska. The climatic conditions and ocean currents are such as to distribute species found in Bering Sea, and about the Aleutian and especially the Commander Islands, southward on the western side of the Pacific Ocean along the shores of the Kurile

Islands and Japan, with quite as much probability as on the eastern side of the Pacific along the shores of Alaska, British Columbia, and California. And I have recently been informed by Mr. J. F. Abbott, of St. Louis, Missouri, that a number of the Japanese nemerteans apparently belong to the same species as those which he has collected at Pacific Grove, California.

So far as can be determined from these collections, the local distribution of the 20 genera of nemerteans at present known from the west coast of North America is indicated in the following table. The figures represent the total number of species of each genus which have thus far been recorded in each of the eight principal zones into which the region may conveniently be divided.

As shown by the accompanying table, the present report deals with 86 species distributed among 20 genera. Of these 20 genera the one most abundantly represented both in number of species and abundance of individuals is AMPHIPORUS with 21 distinct species, of which but two (*A. cruentatus* and *A. angulatus*) have been recorded from other parts of the globe. TETRASTEMMA and CEREBRATULUS are each represented with 10 species, MICRURA has 8, while CARINELLA and LINEUS have 7 species each. PARANEMERTES with 4 species is known only from the Pacific coast, as is also the case with CARINOMELLA with but a single species. EMPLECTONEMA, ZYGONEMERTES, and TAENIOSOMA each have 3 species, while the remaining genera are represented, so far as at present known, with a single species each.

In regard to number of species known from the different regions of the Pacific coast and the adjacent waters, but 6 forms have as yet been recorded between the equator and southern California; this is doubtless due to the small number of collections which have been made in those localities. There are 37 species which have been collected at San Pedro, San Diego, and in the off-shore waters of southern California, and 34 from Monterey Bay and adjacent waters off the coasts of central and northern California.

The region about Puget Sound and British Columbia, embracing as it does a great number of islands separated by narrow fiords through which the tides run swiftly, thus providing an abundance of pure water and food materials, furnish almost ideal conditions for a luxuriant growth of nearly all classes of marine invertebrates, and in few other places on the globe are these animals so abundant. Ne-

DISTRIBUTION OF SPECIES OF NEMERTEANS ON PACIFIC COAST OF NORTH AMERICA.

Number of Species.

Genus.	South of California.	Southern California.	Central and Northern California.	Puget Sound and British Columbia.	Pacific Coast of Alaska.	Aleutian Islands.	Bering Sea.	Arctic Ocean.	Total.
1. Carinella . . .	—	4	5	3	3	1	—	—	7
2. Carinomella . .	—	1	—	—	—	—	—	—	1
3. Carinoma . . .	—	1	1	1	—	—	—	—	1
4. Cephalothrix .	—	1	1	1	1	—	—	—	1
5. Taeniosoma . .	1	1	1	1	1	—	—	—	3
6. Zygeupolia . .	—	1	—	—	—	—	—	—	1
7. Lineus	1	5	3	—	2	—	—	—	7
8. Euborlasia . .	1	—	—	—	—	—	—	—	1
9. Micrura . . .	—	2	4	3	3	—	1	—	8
10. Cerebratulus . .	1	4	3	5	7	1	3	—	10
11. Emplectonema .	—	—	1	2	2	2	—	—	3
12. Nemertopsis . .	—	—	1	—	—	—	—	—	1
13. Paranemertes .	—	2	1	2	3	1	1	—	4
14. Carcinonemertes	—	—	1	—	—	—	—	—	1
15. Zygonemertes .	—	1	1	1	1	—	—	—	3
16. Amphiporus . .	1	8	7	9	7	4	4	1	21
17. Drepanophorus .	—	1	—	—	—	—	—	—	1
18. Tetrastemma .	—	5	3	—	3	—	—	—	10
19. Planktonemertes	1	—	—	—	—	—	—	—	1
20. Malacobdella .	—	—	1	—	—	—	—	—	1
Total	6	37	34	28	33	9	9	1	86

merteans form no exception to this rule, as the few attempts made at their collection attest. In the material at hand there are 28 species, but this number doubtless represents but a portion of those which actually occur in those regions. It seems likely that more than double this number will eventually be found there. A number of species not yet recorded from Puget Sound or British Columbia have been collected both north and south of those localities.

From the Pacific coast of Alaska, east of the Aleutian Islands, 33 species are recorded. Very little collecting has as yet been done at or near the Aleutian Islands, and only 9 species are known from this locality. On the Commander Islands, off the coast of Kamchatka, at the Pribilof Islands and from other portions of the Bering Sea, 9 species have been obtained, for the most part by means of the dredge. From the Arctic Ocean but a single species is represented in these collections, and that was obtained at two localities north of 70° N. Lat., or near the most northern point of land in Alaska. Several other forms, however, have been collected in Bering Strait, and might, perhaps, have properly been included with the single Arctic species. The ocean north of Bering Strait is, however, practically unexplored for invertebrates.

It is also worthy of note that 20 of the 86 species as yet known from the Pacific coast have been found in southern California only, and are not known to occur in the much colder water north of Point Conception. On the other hand, 8 forms are common both to Monterey Bay and southern California, but have not been met with elsewhere. There are 16 species which extend from Alaska to Monterey Bay, of which 8 extend the whole length of the coast from Alaska to southern California. Some of these latter have a distribution of more than 5000 miles on the Pacific coast and Bering Sea alone, besides being found in other portions of the world. This range represents extremely varied environmental conditions, including a difference in temperature of the water varying from that of nearly constant summer temperature to one which is never more than a degree or two above the freezing point. Such species are usually remarkably hardy and occur in all sorts of situations from half tide to a depth of a hundred or more fathoms. Extended geographical range is often correlated with ability to withstand very varied conditions of local environment.

On the whole, the observations on the distribution of the Pacific

forms agree well with those previously made on genera and species in other parts of the world. The region from southern California northward, where nearly all the collections on which this report is based were obtained, being situated in the temperate and arctic zones, the nemertean fauna would be expected to contain a large proportion of species belonging to the genera Carinella, Emplectonema, Amphiporus, Tetrastemma, Lineus, Micrura, and Cerebratulus, and these are, in fact, the most abundant genera. Taeniosoma, the genus especially characteristic of the tropics is represented by only three species, of which one occurs only on the tropical coast of Panama and Mexico, and only one species of this genus has been found in Alaska. Drepanophorus, another genus common in the tropics, is represented by a single species from southern California.

In the arctic region from the Bering Sea northward occur only 4 genera and 10 species, so far as these collections indicate. Of these, 5 species belong to Amphiporus, so generally common in arctic regions, while 3 species belong to Cerebratulus, another cosmopolitan genus. The remaining two forms belong to Paranemertes and Micrura respectively.

Systematic Position and Relationships.

The systematic position of the Nemertini with relation to the other groups of worms is not perfectly clear and is still to some extent a matter of discussion. The best evidence, however, seems to indicate that they should be classed among the platyhelminthes, and that they are more closely related to the Turbellaria than to any other existing group, although they have many points of similarity with the annelids. They certainly constitute a very highly specialized and aberrant group which, as Bürger ('95, pp. 709, 711) suggests, may possibly have arisen from an ancestral form of the Turbellaria and then developed along lines somewhat similar to those followed by the annelids.

In 1851 Max Schultze proposed the division of the group into the two orders Enopla, including those forms in which the proboscis is provided with stylets, and Anopla, in which stylets are absent. The order Enopla might well be retained, for it includes a well circumscribed group, but the order Anopla has been found to be

made up of forms presenting widely divergent anatomical peculiarities and is now looked upon as a very heterogeneous group.

Further division of this group was made by Hubrecht who, in 1879, established the order Hoplonemertea as equivalent to the Enopla of Max Schultze and divided the Anopla into the order Schizonemertea, or those forms having a pair of deep lateral longitudinal cephalic furrows, and the Paleonemertea, including all other forms which are without proboscidial stylets and without lateral cephalic furrows.

Further anatomical studies, however, have shown that the presence of cephalic furrows is a very artificial distinction, for genera showing great correspondence in their principal anatomical peculiarities, as TAENIOSOMA and the Lineidae, are thus placed in different orders, while widely divergent forms, differing profoundly in arrangement of muscular layers and position of lateral nerves, are brought together in one order. With the recent discovery of ZYGEUPOLIA and several other forms undoubtedly belonging to the Lineidae but without lateral cephalic furrows the objection to Hubrecht's classification becomes still more obvious.

Bürger, in 1892 and 1895, proposed to divide the nemerteans into four orders distinguished by fundamental anatomical peculiarities such as the number and arrangement of the muscular layers of the body, position of lateral nerves, and structure of proboscis. The more important characters of these four orders are as follows:

I. *Protonemertea.* Brain and lateral nerves situated in the epithelium or beneath the basement layer outside the body musculature, which is made up of two layers, often with diagonal fibers between them; mouth situated behind brain; intestinal caecum and stylet apparatus absent.

II. *Mesonemertea.* As in the Protonemertea, except that the brain and lateral nerves lie imbedded in the body musculature.

III. *Metanemertea.* Brain and lateral nerves situated in the parenchyma internal to the body walls; mouth in front of brain; intestinal caecum and stylet apparatus present. Corresponding both with the order Enopla of Max Schultze and that of Hoplonemertea of Hubrecht. MALACOBDELLA is placed in this order by Bürger, although, as stated below, it differs so widely from all other genera as to warrant the establishment of a distinct order for this genus alone.

IV. *Heteronemertea.* Brain and lateral nerves imbedded in the body musculature, which has three distinct layers, sometimes with an additional layer of diagonal fibers. Lateral nerves situated outside circular muscular layer; otherwise as in the Protonemertea. This order corresponds to Hubrecht's Heteronemertea with the addition of the Taeniosomidae.

Although Bürger's classification is an improvement over those which have preceded it, yet I quite agree with Bergendal (:00) that the relationship of CARINOMA with CARINELLA is so very striking that their disposition in different orders is wholly unwarranted, and now that the new genus CARINOMELLA is described in the present article the last objection to the union of those two genera in the same order is removed. For in CARINOMELLA we have (as described below) a form which presents many characters thought to be peculiar to CARINELLA combined with others so strikingly like those of CARINOMA that there was some hesitation as to which of these two genera should receive the new species. The establishment of the new genus CARINOMELLA as a form intermediate in character between CARINELLA and CARINOMA appeared to be the only reasonable procedure. The last barrier between the Protonemertea and the Mesonemertea is thus removed as far as CARINOMA is concerned.

Whether the species of CEPHALOTHRIX should stand alone as the representatives of the order Mesonemertea or whether they should be again placed among the Protonemertea will depend upon further studies of the anatomical peculiarities of this somewhat aberrant genus, whose nephridial system and some other points of anatomy still remain unknown. The fact that there is no more fundamental difference in the muscular layers nor in the position of the lateral nerves than obtains in different portions of the body of certain of the Carinellidae and in CARINOMA would indicate that the genus might be placed with CARINOMA and CARINOMELLA in the Protonemertea without serious objection.

Such a disposition of CEPHALOTHRIX would do away with Bürger's Mesonemertea and leave his three other orders. But the order Protonemertea would thus become practically equivalent with Hubrecht's order Paleonemertea lacking the Taeniosomidae, and this order of Hubrecht's has therefore been adopted in the present article.

I. Paleonemertea. This order will thus include the following families and genera at present known from the Pacific coast:

Family Carinellidae: Carinella, Carinomella.
Carinomidae: Carinoma.
Cephalothricidae: Cephalothrix.

II. Heteronemertea. In regard to the many genera which are characterized by the possession of three muscular layers, of which the middle layer is circular and lies immediately internal to the lateral nerves, the order Schizonemertea is so very inappropriate, as stated above, that Bürger's order Heteronemertea is adopted without hesitation in this article. The following families and genera of this order are known to occur on the Pacific coast:

Family Taeniosomidae: Taeniosoma.
Lineidae: Euborlasia, Lineus, Zygeupolia, Micrura, Cerebratulus.

III. Hoplonemertea. As Bürger's order Metanemertea is equivalent to Hubrecht's older order Hoplonemertea there seems no reasonable ground for discarding the older of the two names, so that Hoplonemertea is adopted in this article, and includes the following families and genera from the Pacific coast:

Family Emplectonemidae: Emplectonema, Nemertopsis, Paranemertes, Carcinonemertes.
Amphiporidae: Amphiporus, Zygonemertes.
Tetrastemmidae: Tetrastemma (Oerstedia).
Drepanophoridae: Drepanophorus.
Pelagonemertidae: Planktonemertes.

IV. Bdellonemertea. The genus Malacobdella differs so widely from all other nemerteans that it clearly demands a distinct order. For this order Verrill ('92, p. 444) proposed the name Bdellomorpha, a name which might reasonably be retained. This name, however, does not conform with those of the three other orders, all of which have the suffix –nemertea, so that I would suggest that the order be, for the sake of uniformity of nomenclature, designated by the new name of Bdellonemertea.

The characters of this order are as follows: Parasitic nemerteans with short, stout, flattened bodies of leech-like appearance and movements, with sucker at posterior end of body; mouth and proboscis have common opening at emarginate anterior end of body; head devoid of lateral grooves, cerebral sense organs and ocelli; proboscis

without stylets; intestine convoluted, longer than body, without diverticula, opening posteriorly at base of sucker.

The order includes a single

Family Malacobdellidae: MALACOBDELLA.

LITERATURE RELATING TO NEMERTEANS OF THE PACIFIC COAST.

Several publications dealing with the nemerteans of the region included in this report have appeared during the past six years. Previous to that time but a single paper, published by Wm. Stimpson in 1857, contained special references to any of the nemerteans of this vast region. Stimpson's paper contains brief Latin diagnoses of three species from the west coast of North America.

These include (1) the common European species, *Emplectonema viride* Stimpson = *E. gracile* (Johnston), found by Stimpson in San Francisco Harbor, and also common along the whole Pacific coast of Alaska; (2) *Cosmocephala beringiana* Stimpson = *Amphiporus angulatus* (Fabr.) from Bering Strait, and which occurs as far south as Puget Sound; (3) *Cerebratulus impressus* Stimpson = *Micrura impressa*, also from Bering Strait.

The first paper dealing exclusively with the nemerteans of this region is a posthumous paper by B. B. Griffin, who had in mind the publication of an extended monograph on the nemerteans of Puget Sound. His preliminary report, which appeared in 1898, contains brief diagnoses of twelve named species, besides two forms which are not designated by specific names.

These were collected by Griffin at the following localities:

1. *Carinella sexlineata* Griffin. Puget Sound; Sitka, Alaska.

2. *C. rubra* Griffin. Puget Sound; Sitka, Alaska.

3. *Carinoma mutabilis* Griffin. Puget Sound; Strait of Juan de Fuca. Varieties: *argillina*, in hard blue clay; *rasculosa*, in sand between tides.

4. *Emplectonema viride* Stimpson = *E. gracile* (Johnston) Verrill. Southern Alaska; Puget Sound.

5. *E. violaceum* Griffin (*non* Bürger) = *E. bürgeri* Coe. Port Townsend, Puget Sound. This form, which Griffin considers identical with Bürger's species from the coast of Chile, has been shown elsewhere (Coe, **:04**, p. 115) to have been erroneously referred to this species, but it is identical with *E. bürgeri* Coe.

6. *Amphiporus imparispinosus* Griffin. Sitka, Alaska; Puget Sound.

7. *A. formidabilis* Griffin. Alaska and Puget Sound.

8. *A. brunneus* Griffin. Puget Sound.
9. *A. angulatus* (Fabr.) Verrill. Sitka and Redoubt Bay, Alaska.
10. *A. drepanophoroides* Griffin. No locality given.
11. *Lineus striatus* Griffin. Puget Sound. Perhaps = *Micrura impressa* (Stimps.) Coe from Bering Strait.
12. *Cerebratulus marginatus* Renier. Puget Sound.
13. *Lineus* sp.? (= *L. viridis*?). Puget Sound.
14. *Cerebratulus* sp.? (= *C. herculeus*?). Locality not stated.

Careful comparison of Griffin's notes, drawings and material indicates that eight of the twelve above named species were new to science at time of publication. Six of these are common forms which have been more fully described anatomically in my own report (:01) on the Nemerteans of Alaska. The other two (*Amphiporus brunneus* and *A. drepanophoroides*) cannot be referred to any forms which have come into my hands, and must stand as new for the present. One other species (*E. bürgeri* Coe), although undescribed at the time, was incorrectly referred to *E. violaceum* Bürger. Three of the four remaining forms were correctly identified with European species, while the one species remaining, *Lineus striatus*, is possibly identical with *M. impressa* (Stimpson), as stated above.

In 1901 the present writer published an extended report on the Nemerteans collected on the Harriman Alaska Expedition of 1899. This paper contains detailed descriptions of 32 species, of which 27 were thought to be new to science. The paper by Griffin, however, antedates the above, and 5 of his species have priority over a similar number which were erroneously thought to be new. The synonymy of these 5 species is given below. The report on the nemerteans of the Harriman Expedition contains colored figures of 23 of the species described, and is accompanied by seven plates of anatomical peculiarities. A single genus (Paranemertes), with 3 species, is described as new. Detailed anatomical descriptions are given of nearly all of the 32 species enumerated.

The geographical distribution of these forms is given in this report as follows:

Paleonemertea.

1. *Carinella speciosa* Coe (= *rubra* Griffin). Pacific coast of Alaska; Vancouver Island, B. C.

2. *C. dinema* Coe (= *sexlineata* Griffin) Victoria, B. C.; Sitka, Alaska.
3. *C. capistrata* Coe. Prince William Sound, Alaska.
4. *Cephalothrix linearis* (Rathke) Oersted. Pacific coast of Alaska.
5. *Carinoma griffini* Coe (= *mutabilis* Griffin) Vancouver Island, B. C.

Hoplonemertea.

6. *Emplectonema gracile* (Johnston) Verrill. Pacific coast of Alaska; San Francisco, California.
7. *E. bürgeri* Coe. Glacier Bay; Sitka, Alaska.
8. *Zygonemertes thalassina* Coe. Sitka, Alaska.
9. *Z. albida* Coe. Victoria, B. C.
10. *Paranemertes peregrina* Coe. Pacific coast of Alaska; Vancouver Island, B. C.
11. *P. pallida* Coe. Yakutat Bay; Popof Island, Alaska.
12. *P. carnea* Coe. Pacific coast of Alaska; Vancouver Island, B. C.
13. *Amphiporus angulatus* (Fabricius) Verrill. Pacific coast of Alaska.
14. *A. bimaculatus* Coe. Southeast coast of Alaska; Puget Sound.
15. *A. tigrinus* Coe. Farragut Bay, Alaska.
16. *A. nebulosus* Coe. Kukak Bay, Alaska Peninsula.
17. *A. leuciodus* Coe (= *imparispinosus* Griffin). Southeast coast of Alaska.
18. *A. exilis* Coe (= *formidabilis* Griffin). Pacific coast of Alaska.
19. *Tetrastemma bicolor* Coe. Kadiak, Alaska.
20. *T. aberrans* Coe. Glacier Bay and Prince William Sound, Alaska.
21. *T. caecum* Coe. Kadiak, Alaska.

Heteronemertea.

22. *Taeniosoma princeps* Coe. Southeast coast of Alaska.
23. *Lineus viridis* (Fabricius) Verrill. Annette Island, Alaska.
24. *L. torquatus* Coe. Prince William Sound, Alaska.
25. *Micrura verrilli* Coe. Prince William Sound, Alaska.
26. *M. alaskensis* Coe. Southeast coast of Alaska.
27. *Cerebratulus herculeus* Coe. Sitka, Alaska.
28. *C. marginatus* Renier. Sitka, Alaska.
29. *C. occidentalis* Coe. Yakutat and Prince William Sound, Alaska; Vancouver Island, B. C.
30. *C. longiceps* Coe. Yakutat, Alaska.
31. *C. montgomeryi* Coe. Puget Sound to Unalaska Island.
32. *C. albifrons* Coe. Near Sitka, Alaska.

A single species (*Amphiporus paulinus*) has been described by Punnett (:01) from the Pribilof Islands, Bering Sea. A brief sum-

mary of the anatomical peculiarities of this form is to be found in the systematic account of species. This author also mentions a small white species from the Commander Islands. This he considers identical with *A. leuciodus* Coe (= *A. imparispinosus* Griffin).

In a second paper on the Nemerteans of the Pacific Coast, published in the Scientific Results of the Harriman Alaska Expedition, the present writer (:04) enumerates 21 species in addition to the 32 mentioned in the first portion of the report. These were collected mainly on the coast of California, where were also found 14 of the 32 species described in the paper on the Alaska Nemerteans (:01).

Of the 21 species included in this second paper, 18 forms were described as new to science, three only — *Amphiporus cruentatus*, *Tetrastemma* (*Oerstedia*) *dorsale*, and *Zygeupolia littoralis* — having previously been described from other parts of the world.

With the exception of *Carcinonemertes epialti*, all of the 18 species which are recorded as new are represented by colored drawings. There are also several plates of anatomical peculiarities.

The geographical distribution of these forms is given as follows:

Paleonemertea.

1. *Carinella frenata* Coe. San Pedro, California.
2. *C. albocincta* Coe. Off San Pedro, California.
3. *C. cingulata* Coe. Monterey Bay, California.

Hoplonemertea.

4. *Nemertopsis gracilis* Coe. Monterey Bay, California.
5. *Paranemertes californica* Coe. Southern coast of California.
6. *Carcinonemertes epialti* Coe. Parasitic on Epialtus. Monterey Bay, California.
7. *Amphiporus cruentatus* Verrill. Monterey Bay and San Pedro, California; southern coast of New England.
8. *Tetrastemma signifer* Coe. San Pedro, California.
9. *T. nigrifrons* Coe. Monterey Bay, California.
10. *T. bilineatum* Coe. San Diego, California.
11. *T. quadrilineatum* Coe. San Pedro, California.
12. *T.* (*Oerstedia*) *dorsale* (Abildgaard). Monterey Bay, California; northern coasts of Europe; Mediterranean Sea; east coast of United States.
13. *T.* (*Oerstedia*) *reticulatum* Coe. San Pedro, California.

Heteronemertea.

14. *Taeniosoma punnetti* Coe. Monterey Bay and San Pedro, California.
15. *Zygeupolia littoralis* C. B. Thompson. San Pedro, California; New England.
16. *Lineus rubescens* Coe. Monterey Bay and San Pedro, California.
17. *L. flavescens* Coe. Southern coast of California.
18. *L. pictifrons* Coe. San Pedro, California.
19. *L. wilsoni* Coe. Monterey Bay, California.
20. *L. albolineatus* Coe. Monterey Bay and San Pedro, California.
21. *Micrura nigrirostris* Coe. San Pedro, California.

With the 32 species recorded in the first portion of the report, two (*Amphiporus brunneus* and *A. drepanophoroides*) described by Griffin ('98), one (*Micrura impressa*) by Stimpson ('57), and one (*Amphiporus paulinus*) by Punnet (:01), the above 21 forms make a total of 57 species recorded from the Pacific coast of North America and the Bering Sea.

The present report adds 29 species and includes the whole region from the equator northward into the Arctic Ocean. This brings the total number of forms known from this vast region up to 86 species, which are described on the following pages.

Species New to Region.

The material which has been studied in the preparation of this report contains some 27 species which have not previously been recorded from the Pacific coast, besides two species (*Taeniosoma mexicana* and *Planktonemertes agassizii*), which have been previously recorded from Panama and the tropical Pacific but which have not been included in the papers mentioned above. These have been collected at the following localities:

Paleonemertea.

1. *Carinella pellucida* Coe. Monterey Bay, San Pedro and San Diego, California; southern coast of New England.
2. *Carinomella lactea*, gen. et sp. nov. San Pedro, California.

Heteronemertea.

3. *Taeniosoma mexicana* Bürger. Panama.
4. *Euborlasia maxima*, sp. nov. Gulf of California.

5. *Micrura pardalis*, sp. nov. Pacific Grove, California.

6. *M. olivaris*, sp. nov. Pacific Grove, California, low water; off San Francisco, California, 68 fms.

7. *M. griffini*, sp. nov. San Pedro, California.

8. *M. nebulosa*, sp. nov. South of Alaska Peninsula, 483 fms.

9. *Cerebratulus signatus*, sp. nov. Bering Sea, 61 fms.

10. *C. lineolatus*, sp. nov. Southern California.

11. *C. californiensis*, sp. nov. Southern California, low water to 28 fms.

12. *C. latus*, sp. nov. Off central California to Bering Sea, low water to 135 fms.

HOPLONEMERTEA.

13. *Emplectonema purpuratum*, sp. nov. Adahk Island, Alaska.

14. *Zygonemertes virescens* (Verrill) Montgomery. Coast of California; eastern coast of United States.

15. *Amphiporus similis*, sp. nov. Monterey Bay, California.

16. *A. punctatulus*, sp. nov. Catalina Island, California, surface.

17. *A. gelatinosus*, sp. nov. Southwest of Kadiak Island, Alaska, 159 fms.

18. *A. californicus*, sp. nov. San Pedro and San Diego, California, low water to 50 fms.

19. *A. macracanthus*, sp. nov. Arctic Ocean at Cape Smyth and Wainwright Inlet, Alaska.

20. *A. pacificus*, sp. nov. Off central California to Bering Sea, 47 to 97 fms. (Gulf of California?)

21. *A. occidentalis*, sp. nov. Off Washington, 40 to 97 fms.

22. *A. rubellus*, sp. nov. Off San Pedro, California, 20 to 50 fms.

23. *A. flavescens*, sp. nov. Coast of California.

24. *A. leptacanthus*, sp. nov. Off San Pedro, California.

25. *A. fulvus*, sp. nov. Southern California.

26. *Drepanophorus ritteri*, sp. nov. Off southern California, 50 to 150 fms.

27. *Tetrastemma albidum*, sp. nov. Coast of California.

28. *Planktonemertes agassizii* Woodworth. Surface in equatorial regions between 79° and 90° W. Long.

BDELLONEMERTEA.

29. *Malacobdella* sp. Pacific Grove, California.

The fact that 11 of these 29 species belong to the genus AMPHIPORUS indicates the great abundance of forms and diversity of structure which this genus has developed on the Pacific coast. Of

the above species, 24 are believed to be undescribed, 2 only are known from other parts of the world, while 2 other forms — *Taeniosoma mexicana* and *Planktonemertes agassizii* — have previously been recorded from the same localities. The single species of MALACOBDELLA is known from one specimen only, and has not been sufficiently studied to determine whether or not it is specifically distinct from those occurring in other parts of the world.

In addition to the above species of marine nemerteans, Professor Trevor Kincaid of the University of Washington informs me that he has found a fresh-water form (STICHOSTEMMA) in the vicinity of Seattle, Washington. This genus therefore is probably distributed from the Atlantic to the Pacific coasts of North America, having previously been collected at numerous localities on the Atlantic seaboard, in the states about the Great Lakes, in Nebraska, and now in Washington. Its distribution through human agencies, by the transportation of water-plants, is easily accomplished.

Distribution of the Pacific Coast Species.

Including the above, there are 86 species which are at present known from the Pacific coast, and their distribution, so far as can be determined from the collections which have come into my hands, is as follows:

Paleonemertea.

1. *Carinella rubra* Griffin. Aleutian Islands; Pacific coast of Alaska; Vancouver Island, B. C.; Puget Sound; Pacific Grove, California.
2. *C. sexlineata* Griffin. Sitka, Alaska, to San Pedro, California.
3. *C. capistrata* Coe. Prince William Sound, Alaska, to Monterey Bay, California.
4. *C. frenata* Coe. San Pedro, California.
5. *C. albocincta* Coe. Off San Pedro, California, 50–100 fms.
6. *C. cingulata* Coe. Monterey Bay, California.
7. *C. pellucida* Coe. Coast of California from Monterey Bay to San Diego; eastern coast of United States, Long Island Sound to Cape Cod.
8. *Carinomella lactea*, gen. et. sp. nov. San Pedro, California.
9. *Carinoma mutabilis* Griffin. Vancouver Island, B. C., to San Diego, California.
10. *Cephalothrix linearis* (Rathke) Oersted. Whole Pacific coast of Alaska to southern coast of California; New England; northern coasts of Europe; Mediterranean Sea.

Heteronemertea.

11. *Taeniosoma princeps* Coe. Pacific coast of Alaska; Puget Sound.

12. *T. mexicana* Bürger. Panama and Mexico; Galapagos Islands.

13. *T. punnetti* Coe. Monterey Bay and San Pedro, California.

14. *Zygeupolia littoralis* C. B. Thompson. San Pedro, California. New England (Woods Hole, Massachusetts).

15. *Lineus viridis* (Fabr.) Verrill. Southeastern coast of Alaska; eastern coast of North America; Greenland; northern coasts of Europe; Mediterranean Sea.

16. *L. torquatus* Coe. Pacific coast of Alaska.

17. *L. rubescens* Coe. Monterey Bay and San Pedro, California.

18. *L. flavescens* Coe. Southern coast of California.

19. *L. pictifrons* Coe. San Pedro, California; Lower California.

20. *L. wilsoni* Coe. Coast of California.

21. *L. albolineatus* Coe. Monterey Bay and San Pedro, California.

22. *Euborlasia maxima*, sp. nov. Gulf of California.

23. *Micrura nigrirostris* Coe. San Pedro, California.

24. *M. verrilli* Coe. Pacific coast of Alaska to Monterey Bay, California.

25. *M. impressa* (Stimpson) Coe. Bering Strait. Puget Sound (?)

26. *M. pardalis*, sp. nov. Pacific Grove, California.

27. *M. olivaris*, sp. nov. Pacific Grove, California, low water; off San Francisco, California, 68 fms.

28. *M. alaskensis* Coe. Pacific coast of Alaska to San Pedro, California.

29. *M. griffini*, sp. nov. San Pedro, California.

30. *M. nebulosa*, sp. nov. South of Alaska Peninsula, 483 fms.

31. *Cerebratulus herculeus* Coe. Pacific coast of Alaska.

32. *C. marginatus* Renier. Southeastern coast of Alaska to southern coast of California; northeastern coast of North America; Greenland; coasts of Europe; Great Britain; Mediterranean Sea; Madeira.

33. *C. signatus*, sp. nov. Bering Sea, 61 fms.

34. *C. lineolatus*, sp. nov. Southern California.

35. *C. occidentalis* Coe. Pacific coast of Alaska to State of Washington.

36. *C. albifrons* Coe. Southeastern coast of Alaska to southern coast of California.

37. *C. longiceps* Coe. Yakutat Bay, Alaska.

38. *C. montgomeryi* Coe. Bering Strait; Bering Sea; Aleutian Islands to Puget Sound. Low water to 85 fms.

39. *C. californiensis*, sp. nov. Southern California, low water to 28 fms.

40. *C. latus*, sp. nov. Sitka, Alaska, at low water; off Central California to Bering Sea, 40 to 135 fms.

Hoplonemertea.

41. *Emplectonema gracile* (Johnston) Verrill. Aleutian Islands; Pacific coast of Alaska to Monterey Bay, California; northern coasts of Europe; Mediterranean Sea; Madeira.

42. *E. bürgeri* Coe. Southern coast of Alaska to Puget Sound.

43. *E. purpuratum*, sp. nov. Adahk Island (Aleutian group), Alaska.

44. *Zygonemertes thalassina* Coe. Sitka, Alaska.

45. *Z. virescens* (Verrill) Montgomery. Coast of California; eastern coast of United States.

46. *Z. albida* Coe. British Columbia.

47. *Nemertopsis gracilis* Coe. Monterey Bay, California.

48. *Paranemertes peregrina* Coe. Commander Islands; Aleutian Islands; Pacific coast of Alaska to southern coast of California.

49. *P. pallida* Coe. Pacific coast of Alaska.

50. *P. carnea* Coe. Pacific coast of Alaska and British Columbia.

51. *P. californica* Coe. Southern coast of California.

52. *Carcinonemertes epialti* Coe. Parasitic on *Epialtus productus*. Monterey Bay, California.

53. *Amphiporus angulatus* (Fabr.) Verrill. Bering Strait to Puget Sound; New England to Greenland.

54. *A. bimaculatus* Coe. Southern Alaska; Puget Sound to Monterey Bay, California.

55. *A. tigrinus* Coe. British Columbia.

56. *A. nebulosus* Coe. Pacific coast of Alaska Peninsula.

57. *A. cruentatus* Verrill. Monterey Bay and San Pedro, California; eastern coast of United States.

58. *A. imparispinosus* Griffin. Bering Strait; Commander Islands; Aleutian Islands; Pacific coast of Alaska to southern coast of California.

59. *A. similis*, sp. nov. Monterey Bay, California.

60. *A. formidabilis* Griffin. Aleutian Islands, Alaska, to Monterey Bay, California.

61. *A. paulinus* Punnett. Pribilof Islands, Bering Sea.

62. *A. punctatulus*, sp. nov. Catalina Island, California, surface.

63. *A. gelatinosus*, sp. nov. Southwest of Kadiak Island, Alaska; 159 fms.

64. *A. californicus*, sp. nov. San Pedro and San Diego, California; low water to 50 fms.

65. *A. macracanthus*, sp. nov. Arctic Ocean at Cape Smyth and Wainwright Inlet, Alaska.

66. *A. pacificus*, sp. nov. Off Central California to Bering Sea; 47 to 97 fms.; (Gulf of California?).

67. *A. occidentalis*, sp. nov. Off Washington; 40 to 97 fms.

68. *A. rubellus*, sp. nov. Off San Pedro, California; 20 to 50 fms.

69. *A. flavescens*, sp. nov. Coast of California.

70. *A. leptacanthus*, sp. nov. Off San Pedro, California; 20 to 50 fms.

71. *A. fulvus*, sp. nov. Southern California.

72. *A. brunneus* Griffin, Puget Sound.

73. *A. drepanophoroides* Griffin. Puget Sound.

74. *Drepanophorus ritteri*, sp. nov. Off southern California; 50 to 150 fms.

75. *Tetrastemma signifer* Coe. San Pedro, California.

76. *T. nigrifrons* Coe. Monterey Bay, California.

77. *T. bicolor* Coe. Kadiak, Alaska.

78. *T. aberrans* Coe. Pacific coast of Alaska.

79. *T. albidum*, sp. nov. Coast of California.

80. *T. bilineatum* Coe. San Diego, California.

81. *T. quadrilineatum* Coe. San Pedro, California.

82. *T.* (*Oerstedia*) *dorsale* (Abildgaard). Monterey Bay, California; northern coasts of Europe; Mediterranean Sea; east coast of United States.

83. *T.* (*Oerstedia*) *reticulatum* Coe. San Pedro, California.

84. *T. caecum* Coe. Kadiak, Alaska.

84a. *Stichostemma*. sp. Fresh water pools, Washington. See p. 91.

85. *Planktonemertes agassizii* Woodworth. Surface in equatorial regions between 79° and 90° W. Long.

Bdellonemertea.

86. *Malacobdella* sp. Pacific Grove, California.

When not otherwise particularly noted, all of the species enumerated have been collected on the shore between tides, on piles of wharves, or dredged from shallow water near the shore. They should not be considered as strictly littoral forms, however, for most of them probably range from between tides to a depth of 50 fathoms or more.

Keys to Groups and Species.

For convenience in determination, the species at present known from the west and northwest coasts of North America, from Panama to the Bering Sea and Arctic Ocean, may be arranged in the following analytical table, based mainly on superficial and easily distinguishable characters.

1. Without sucker; intestine not convoluted.
  2. Proboscis without stylets; mouth posterior to brain; intestinal caecum absent.
    3. Muscular walls of body in two layers — outer circular and inner longitudinal — to which a third — inner circular — is sometimes added; lateral nerves either outside muscular layers or imbedded in longitudinal muscles; cutis absent.
    Order PALEONEMERTEA.
    3[1]. Muscular walls of body in three main layers, of which the inner is longitudinal; lateral nerves outside circular muscular layer; cutis well developed . . Order HETERONEMERTEA.
  2[1]. Proboscis usually provided with stylets; mouth in front of brain, usually opening with proboscis in a single terminal or subterminal pore; intestinal caecum usually present; lateral nerves internal to muscular layers of body walls . Order HOPLONEMERTEA.
1[1]. With sucking disk at posterior end of body; intestine convoluted.
Order BDELLONEMERTEA.

PALEONEMERTEA.

A. Paired intestinal diverticula absent . . . . . B.
  B. Lateral nerves situated immediately outside circular muscles of body walls . . . . . . CARINELLA, p. 108.
    a. Body of somewhat homogeneous color, without definite markings.
      1. Body very soft, attaining a length of upwards of 2 meters when fully extended; color deep red; orange, or bright vermilion . . . . *C. rubra*, p. 109.
      2. Body minute, very slender, whitish and somewhat translucent.
      C. pellucida, p. 122.
    aa. With distinct longitudinal and transverse markings . b.
      b. Color yellow, rosy or greenish, with black longitudinal and transverse markings.
        1. Body large, rather firm, only moderately slender, attaining a length of 50 cm. or more; pale yellowish or rosy, sometimes with greenish tinge, with 3 longitudinal, velvety, black lines and a series of narrow rings of similar color . . . . . . *C. frenata*, p. 115.
      bb. Color red or brown, with white markings . . . c.
        c. Color deep red, with a series of narrow white rings, but without longitudinal lines.
          1. Body firm, rather stout, upwards of 30 cm. long; deep red, with a series of narrow white rings placed at frequent intervals throughout body . . *C. albocincta* p. 118.

cc. Color brown, with longitudinal and transverse white markings.

1. Body slender, up to a meter in length; color brown, with numerous narrow transverse rings and three parallel, longitudinal white lines, of which one is in the dorso-median line and one just below each lateral margin. *C. capistrata*, p. 114.
2. Body slender, subcylindrical, 15 cm. or more in length; color deep brown, with a series of white rings and four longitudinal white lines, of which two are lateral, while the other two divide dorsal surface of body into three equal parts . . . . *C. cingulata*, p. 120.
3. Body slender, subcylindrical, often half a meter or more in length when fully extended; color brown or chocolate, with numerous narrow transverse rings and five or six parallel longitudinal white lines, of which one is in the median dorsal line, two on each lateral surface, and the sixth, when present, is usually merely indicated in the ventro-median line . . *C. sexlineata*, p. 111.

BB. Lateral nerves situated outside muscular layers in esophageal region, but imbedded in longitudinal muscles behind nephridial region; intestine lobed, but without paired diverticula; cerebral sense organs wanting . . CARINOMELLA, p. 125.

1. Body slender, usually 5 to 10 cm. in length; milk-white and somewhat translucent, sometimes with yellowish or brownish intestinal canal . . . . . . *C. lactea*, p. 127.

AA. Paired intestinal diverticula present . . . . . . **C.**

C. Internal circular muscles enormously developed in nephridial region; mouth situated immediately behind brain; body not very slender; head broader than neck; nephridia well developed . . . . CARINOMA, p. 143.

1. Body rather stout, flattened posteriorly; milk-white, with grayish or brownish mottlings and darker intestinal lobes. *C. mutabilis*, p. 144.

CC. Internal circular muscles but little developed in any portion of body; mouth situated far behind brain; body filiform; head sharply pointed; nephridia not known. CEPHALOTHRIX, p. 153.

1. Slender, filiform; whitish or pale yellow, sometimes with reddish, grayish or greenish tinge; no ocelli in adult. *C. linearis*, p. 153.

Heteronemertea.

A. Proboscis musculature of two layers, of which the outer is circular; muscular crosses absent in proboscis; cephalic glands usually very voluminous, extending posteriorly behind brain; cephalic furrows absent . . . . Taeniosoma, p. 154.

1. Body of very large size, sometimes 2 meters or more in length and 18 mm. in diameter; color deep yellow, thickly sprinkled with small, irregular, dark red dots . . *T. princeps*, p. 156.
2. Body large, soft, flabby, 40 to 60 cm. in length; color deep red, mahogany, or reddish brown, sometimes covered with whitish bloom; head with broad spot of darker color and terminal border of white; ventral surface of same general color, but paler, except ventral side of head which is whitish. *T. punnetti*, p. 158.
3. Body of moderate diameter, but of great length, often much exceeding a meter, somewhat flattened; color brown, with a great number of narrow rings of whitish encircling the body. *T. mexicana*, p. 157.

AA. Proboscis musculature of two or three layers, of which the outer is longitudinal; muscular crosses present in proboscis; cephalic glands usually but little developed, and not extending posterior to brain . . . . **B.**

B. Without horizontal cephalic furrows on sides of head; caudal cirrus present . . . . Zygeupolia, p. 160.

1. Body slender, 5 to 10 cm. in length; head acutely pointed; cephalic furrows absent, the canal from each cerebral sense organ opening into a small pit on side of head; caudal cirrus conspicuous, whitish in color; general color of body whitish or flesh color, becoming yellowish, rosy, or pale brown in intestinal region and pure white on head. *Z. littoralis*, p. 160.

BB. With conspicuous horizontal cephalic furrows on sides of head. **C.**

C. Caudal cirrus absent; proboscis sheath usually considerably shorter than body . . . . **D.**

D. Body remarkably thick and massive, usually nearly cylindrical when fully extended, but very broad and much flattened in intestinal region when strongly contracted; ocelli wanting; muscular layers of body possess a reddish tinge. Euborlasia, p. 175.

1. Body of gigantic size for a worm, with a greater diameter than in any other described species of nemertean, becoming 45 mm. wide in intestinal region; color dark brown, perhaps with an olive tinge; head paler, with brown mottlings . . . . . *E. maxima*, p. 175.

DD. Body long and slender, rounded or flattened, very contractile; ocelli present in most species . . LINEUS, p. 161.

a. Head and body not strikingly different in color; without distinct markings.

1. Dusky or brownish green, dark brown or reddish brown, commonly paler beneath; a single row of 4 to 8 ocelli on each side of head . . . . *L. viridis*, p. 162.
2. Yellowish, pale yellow with tinge of orange, dull orange, ochre, buff or yellowish brown; margins of head pale or colorless; with 3 to 7 irregular red, purple or black ocelli, of which the most anterior are largest.
L. flavescens, p. 166.

aa. Snout and body of different color or with distinct markings on body . . . . **b.**

b. With conspicuous median dorsal stripe, but without transverse markings.

1. Body deep brown or olive, with median dorsal stripe of white or lemon yellow extending whole length of body and widening out on head to form a broad white marking . . . . *L. albolineatus*, p. 173.

bb. Without conspicuous median dorsal stripe . . **c.**

c. With one or more narrow transverse rings of paler color.

1. Body and head dark reddish brown or purple, with a narrow transverse white band connecting posterior ends of cephalic furrows across dorsal surface of neck . . . . . *L. torquatus*, p. 163.
2. Body soft and flabby; deep brown, chestnut or slaty, sometimes with greenish tinge; with transverse lemon yellow rings at intervals along whole length of body and with 7 to 15 very inconspicuous, fine, hair-like longitudinal lines of yellow color on dorsal surface; of these latter the median line is more distinct than the others and connects the diamond-shaped enlargements of the transverse rings; tip of snout white, usually with 2 orange-colored spots.
L. pictifrons, p. 169.
3. Body slender, deep brown, chocolate or drab, paler beneath, with series of very narrow and inconspicuous white rings; tip of snout and borders of cephalic furrows white . . . *L. wilsoni*, p. 171.

cc. Without transverse rings of paler color.

1. Body pink, rosy flesh color, or pinkish red, sometimes with tinge of blue; snout white both above and

below, sharply marked off from rosy color of body; often with bluish tinge after preservation.

L. rubescens, p. 164.

CC. Caudal cirrus present; proboscis sheath usually extends nearly or quite to posterior end of body . . . . . **E.**

E. Body rather firm, lateral margins not remarkably thin; incapable of swimming; neurochord cells absent in many species . . . . MICRURA, p. 177.

a. Body with conspicuous transverse rings of white.

1. Body rounded; deep purple or reddish brown above, with a series of narrow transverse rings throughout length of body; pure white beneath and on lateral margins of body; tip of snout deep orange or vermilion; caudal cirrus white, conspicuous.

M. verrilli, p. 179.

2. Body flattened, dusky gray above with narrow, colorless transverse bands and a flesh-colored subtruncate head.

M. impressa, p. 182.

aa. Body without conspicuous transverse rings . . **b.**

b. Dorsal surface with conspicuous spots and blotches.

1. Body rather stout, much flattened; color pale yellow, thickly covered on dorsal surface only with black or dark brown spots and dots often somewhat elongated and arranged in irregular longitudinal lines; a single row of 10 to 18 ocelli on each side of head; nephridia limited to middle third of esophageal region . . . . . *M. pardalis*, p. 183.

2. Body grayish after preservation (color in life unknown), thickly mottled on both dorsal and ventral surfaces with coarse confluent brownish blotches, which often fuse together posteriorly to form a continuous brownish color; nephridia extend forward to mouth region . . . *M. nebulosa*, p. 190.

bb. Body without distinct spots . . . . . . **c.**

c. Color rosy, flesh color or red; ocelli wanting.

1. Body deep red, sometimes purplish in esophageal region and brighter red anteriorly; head bright red with a narrow, but very sharp and conspicuous, transverse band of white just behind tip of snout, which is red with a small, dark brown or black spot on the exact tip . . . . . . *M. nigrirostris*, p. 178.

2. Body rosy, pinkish red or dull red with purplish tinge in esophageal region, becoming gradually paler towards

snout, which is white; intestinal region deep flesh color or pale red, or yellowish when sexual products are mature; accessory buccal glands wanting.

M. griffini, p. 188.

3. Salmon or flesh color (rarely light, rosy brown); shading into lighter, with tinges of brighter red, or nearly white anteriorly; intestinal lobes more deeply colored, sometimes brown; a cream-colored stripe is situated in median ventral line; accessory buccal glands well developed . . *M. alaskensis*, p. 187.

cc. Color olive, ochre or buff; ocelli present.

1. Pale olive brown, grayish ochre or buff; deeper brown in intestinal region, and with a paler median dorsal stripe in esophageal region; 6 to 12 or more small black ocelli in an irregular row or elongated cluster on each side of head . . . . *M. olivaris*, p. 184.

EE. Body usually long and ribbon-like, much flattened, with very thin lateral margins; well adapted for swimming; dorso-ventral and diagonal muscles well developed; neurochord cells present in many species.

CEREBRATULUS, p. 191.

a. Snout whitish both above and below, strikingly different from deep color of body.

1. Body very long and ribbon-like, attaining a length of more than two meters; deep blood red above and below, except tip of snout, which is yellowish white.

C. montgomeryi, p. 200.

2. Body long and ribbon-like, very dark brown or reddish purple, except head, which is white on both dorsal and ventral surfaces, back about three-fourths the length of the cephalic furrows, or sometimes nearly or quite to the mouth . . . . *C. albifrons*, p. 198.

aa. Snout not strikingly different from body in color . **b.**

b. Without distinct longitudinal or transverse markings on body . . . . **c.**

c. Color of body black, brown, reddish brown, olive or dark gray, sometimes with paler lateral margins **d.**

d. Body long and ribbon-like.

1. Color slaty brown to grayish or pale olive, paler beneath, and often with conspicuously paler or white lateral margins . *C. marginatus*, p. 193.

2. Color dark brown or purplish, paler on borders of cephalic furrows and tip of snout; head and

anterior portions of body very slender, with remarkably long and deep cephalic furrows.

C. longiceps, p. 199.

3. Color dark reddish brown; body very large and stout, becoming 2 meters or more in length and 25 mm. in width; head and cephalic furrows short . . *C. herculeus*, p. 192.

dd. Body comparatively short and broad.

1. Chestnut brown or reddish in esophageal region, chocolate brown posteriorly; brownish flesh color to reddish brown beneath, usually with median longitudinal ochre stripe along ventral surface . . . *C. occidentalis*, p. 197.

2. Body remarkably broad and much flattened, with very broad lateral margins; head very broad, with remarkably short cephalic furrows; color usually deep brown; ventral surface and lateral margins of body paler . . *C. latus*, p. 203.

cc. Color of body rosy flesh color, cream color or buff.

1. Body of moderate proportions, remarkably fragile; color dull or rosy flesh colored or cream colored anteriorly, head paler, brain and lateral nerves reddish and conspicuous in life, intestinal region cream colored or pale buff. .

C. californiensis, p. 201.

bb. With conspicuous transverse or longitudinal markings on body.

1. Rather slender; color pale gray, with numerous fine, irregular and much interrupted, dark olive brown longitudinal lines extending whole length of body both above and below, but more numerous and larger on dorsal surface than ventrally; markings somewhat resemble those on *Taeniosoma lineolatum* and *T. delineatum* . . *C. lineolatus*, p. 196.

2. Rather short; with conspicuous narrow band of dark color in median dorsal line, and a series of narrow transverse markings of dark color placed side by side on dorso-lateral aspects of body. Other markings may possibly be present in life.

C. signatus, p. 194.

Hoplonemertea.

A. Proboscis sheath not more than three-fourths the length of body; body long and slender . . . . **B**.

B. Proboscis sheath less than half the length of body; proboscis of small size . . . . **C**.

C. Accessory stylets present . . . . **D**.

D. Ocelli minute and usually numerous. Emplectonema, p. 206.

1. Stylets long and slender, curved; basis very long; color of body dark green or pale green above, whitish or very pale greenish beneath . . . . *E. gracile*, p. 207.
2. Stylets straight and short, with swollen heads; basis of central stylet swollen and rounded posteriorly; 11 proboscidial nerves; color of body dark brown above, often with minute purple dots; flesh-colored or yellowish white beneath . . . . . . *E. bürgeri*, p. 209.
3. Stylets straight, without swollen heads, fluted longitudinally; basis of central stylet not swollen posteriorly; 16 proboscidial nerves; color of body purplish or purplish brown from closely placed mottlings on dorsal surface; ventral surface gray or yellowish . . *E. purpuratum*, p. 210.

DD. Ocelli four in number; body filiform. Nemertopsis, p. 217.

1. Length often 15 cm. or more; very pale brown or whitish, with 2 longitudinal dorsal stripes of deep brown; 8 proboscidial nerves . . . . *N. gracilis*, p. 217.

CC. Accessory stylets absent; ocelli large, two in number; proboscis and sheath very rudimentary, with central stylet only; parasitic . . . . Carcinonemertes, p. 230.

1. Length when sexually mature but 4 to 6 mm.; color orange or reddish; parasitic on egg masses of *Epialtus* and perhaps other crabs . . . . . *C. epialti*, p. 231.

BB. Proboscis sheath one-half to three-fourths the length of body; proboscis well developed . . Paranemertes, p. 219.

1. Two or four pouches of accessory stylets; 14 proboscidial nerves; stylets slender, spirally grooved; color purplish brown, dark brown, or orange-brown above, on sides, and on lateral margins of ventral surface; with a whitish angular spot on each side of head; ventral surface (often only the median third) white or yellowish white . . . . . *P. peregrina*, p. 220.
2. Four pouches of accessory stylets; 9 or 10 proboscidial nerves; color opaque white . . . . . *P. pallida*, p. 224.
3. Four or six pouches of accessory stylets; 10 large proboscidial nerves; translucent, pale orange anteriorly, flesh color, grayish

or very pale salmon posteriorly, much obscured by deep green color of intestinal tract . . . *P. californica*, p. 226.

4. Six pouches of accessory stylets; 11 to 13 proboscidial nerves; whitish, pinkish or flesh-color . . . *P. carnea*, p. 225.

AA. Proboscis sheath extends nearly or quite to posterior end of body; body usually not very slender . . . . **E**.

E. Proboscis provided with stylets, intestine not dendrocoelous . **F**.

F. Proboscis sheath without caecal appendages; proboscis armed with single central stylet, besides 2 or more pouches of accessory stylets . . . . **G**.

G. Ocelli numerous, extending posteriorly along lateral nerve cords beyond the brain; basis of central stylet massive, with flattened or concave posterior end.

ZYGONEMERTES, p. 212.

1. Color usually rather pale green, occasionally flesh colored, pale yellow, or white, especially anteriorly; central stylet short, about half as long as basis, not remarkably stubby; usually 2 or 3 accessory stylets in each of 2 lateral pouches; 10 or 11 proboscidial nerves . . *Z. virescens*, p. 214.

2. Color usually rather dark olive green; central stylet remarkably stubby, often less than half as long as basis which is much serrated on posterior border; commonly 5 accessory stylets in each of 2 lateral pouches; 12 proboscidial nerves.

Z. thalassina, p. 213.

3. Body small, whitish, with a tinge of yellow; central stylet rather slender; ocelli extend along lateral nerves for about two-fifths the length of esophageal region.

Z. albida, p. 216.

GG. Ocelli do not extend posteriorly beyond brain; basis of central stylet commonly (but not always) rounded posteriorly.

H.

H. Body usually not very small; ocelli usually numerous, always more than 4 in Pacific coast species.

AMPHIPORUS,[1] p. 233.

a. Body very gelatinous, with an enormous development of the body parenchyma.

1. Body short and broad; ocelli large, 30 or more on each side of the head; cerebral sense organs extremely small, situated in front of brain.

A. gelatinosus, p. 259.

[1] Two species, *A. brunneus* and *A. drepanophoroides* (p. 282), which cannot be referred to any in this key were described by Griffin ('98) from Puget Sound.

aa. Body with only a moderate amount of parenchyma. b.

b. Esophagus provided with large caecum extending on ventral side of esophagus proper and ending blindly posteriorly.

1. Esophageal caecum extends posteriorly far beyond anterior ends of intestinal caeca; body parenchyma but little developed; ocelli numerous. *A. occidentalis*, p. 271.

2. Esophageal caecum terminates posteriorly in front of anterior ends of intestinal caeca; body parenchyma comparatively well developed; ocelli few. *A. rubellus*, p. 274.

bb. Esophagus without ventral caecum . . . c.

c. Proboscis provided with more than 2 pouches of accessory stylets.

1. With 3 pouches of accessory stylets; color white, body slender, ocelli usually less than 40. *A. imparispinosus*, p. 247.

2. With 6 to 12 pouches of accessory stylets; body very slender; color whitish or flesh color; ocelli usually 60 to 250 . . . *A. formidabilis*, p. 250.

3. With 2 or 4 pouches of accessory stylets; body broad and flat; color orange, brownish, or reddish above, with 2 large dark brown or black angular spots on head; ventral surface pale orange or flesh color; 14 or 16 proboscidial nerves. *A. bimaculatus*, p. 241.

4. Occasionally with 4 pouches of accessory stylets; dark brown or purplish, with small, angular white spot on each side of head; ventral surface pink or flesh color; 17 to 20 proboscidial nerves. *A. angulatus*, p. 238.

cc. Proboscis usually provided with only two pouches of accessory stylets . . . . . . d.

d. Ocelli in a single row on each side of head.

1. Body rather slender; 10 to 25 mm. in length; color yellow; blood corpuscles deep red in color; basis and stylet both very slender and of about equal length . . *A. cruentatus*, p. 246.

dd. Ocelli scattered, and not in a single row on each side of head[1] . . . . . . e.

[1] In a single species (*A. leptacanthus*, p. 279) belonging to this group, the relative length of stylet and basis is as yet unknown, and the species is therefore not included in this key.

e. Central stylet and basis of about equal length. f.

f. Cerebral sense organs in front of brain.

1. Body short and broad; color dark purplish or chocolate brown above, with a triangular white spot on each side of head; ventral surface pinkish or flesh color; 17 to 20 proboscidial nerves; basis of moderate proportions. *A. angulatus*, p. 238.

2. Body rather broad and flat; color whitish, thickly mottled with dark brown blotches and dots on dorsal surface only; basis bell-shaped, broad and flattened posteriorly; stylets slender; 17 proboscidial nerves. *A. nebulosus*, p. 245.

3. Body very slender; 15 proboscidial nerves; submuscular glands well developed; intestinal caecum short *A. paulinus*, p. 253.

4. Body of small size, of moderate proportions; color whitish, pale flesh-color, yellowish, ochre or pale orange; basis bell-shaped; 10 or 11 proboscidial nerves. *A. flavescens*, p. 277.

5. Body very small and slender, whitish; ocelli few, in four groups; 1 to 3 accessory stylets in each pouch; 10 proboscidial nerves. *A. similis*, p. 249.

6. Body of small size, rather short and broad; color reddish or orange, paler beneath; ocelli usually only 4 to 8 on each side of head; basis conical, stylets slender; 10 to 12 proboscidial nerves. *A. californicus*, p. 264.

ff. Cerebral sense organs beside brain.

1. Body short and broad; color reddish or brownish above, pale beneath; basis rather slender, of ordinary shape; 14 proboscidial nerves; cerebral sense organs very large. *A. pacificus*, p. 268.

ee. Central stylet about twice as long as basis.

1. Body rather broad and flattened; color orange, brownish or reddish above, with 2 large dark brown or black elongated spots on head; ventral surface pale orange or flesh color; sometimes with 4 pouches of accessory sty-

lets; stylets very slender; 14 or 16 proboscidial nerves; cerebral sense organs beside brain . . *A. bimaculatus*, p. 241.

2. Body rather short and stout; mottled thickly with dark brown dots and blotches; stylets dagger-shaped; 5 to 8 or more in each of the two lateral pouches; basis barrel-shaped; 12 or 13 proboscidial nerves; cerebral sense organs large, situated beside brain.

A. punctatulus, p. 253.

eee. Central stylet considerably shorter than basis. **g**.

g. Central stylet about one-third as long as the remarkably massive basis.

1. Body short and rounded; proboscis remarkably large, provided with 10 nerves; stylets short and conical. *A. macracanthus*, p. 266.

gg. Central stylet about half as long as basis.

1. Body rounded, rather slender; color of females yellowish orange, obscured in intestinal region by dark green ova in breeding season; males yellowish, with white flecks; basis broad, flattened posteriorly; cerebral sense organs in front of brain.

A. tigrinus, p. 243.

ggg. Central stylet about three-fourths as long as basis.

1. Body small, slender, rounded; color brownish with minute dark brown dots; 25 or more ocelli; basis bell-shaped; cerebral sense organs large, situated close in front of brain.

A. fulvus, p. 280.

HH. Body very small; ocelli usually 4, arranged in rectangle; occasionally each of the ocelli is double or fragmented into groups; rarely ocelli are entirely wanting.

TETRASTEMMA, p. 287.

a. With 4 well developed ocelli . . . . . . **b**.

b. Body not especially firm, somewhat flattened . **c**.

c. Without distinct longitudinal stripes of brown on dorsal surface.

1. Body 30 to 60 mm. in length; brownish red above, with median white stripe; ventral surface white; blood corpuscles red; without conspicuous lateral grooves on head. *T. bicolor*, p. 293.

2. Rather slender, 15 to 25 mm. in length; reddish brown both above and below, except head, which is white with a sharply marked wreath of deep brown color on dorsal surface; blood corpuscles red . . . *T. signifer*, p. 287.
3. Usually 20 to 70 mm. in length; head provided with two pairs of very conspicuous, lateral, oblique furrows. Color very variable, except head, which is white with shield-shaped or triangular marking of deep brown color on dorsal surface. Body deep purple, deep brown with white dorsal longitudinal band, reddish with brown flecks, pale brownish, or buff on dorsal surface; of similar colors, but paler, and often with white longitudinal band on ventral surface. Blood corpuscles red. . *T. nigrifrons*, p. 289.
4. Body very slender, usually 10 to 15 mm. in length; color milk white, creamy or flesh colored; basis of central stylet very slender; cerebral sense organs remarkably large, situated beside brain. *T. albidum*, p. 294.

cc. With distinct longitudinal brown stripes on dorsal surface.

1. Only 5 to 10 mm. in length; flesh color, creamy or grayish, with 2 deep brown longitudinal stripes on dorsal surface. . . *T. bilineatum*, p. 296.
2. Usually 8 to 12 mm. in length; whitish, with 4 deep brown longitudinal stripes, of which 2 lie on lateral margins and 2 on dorsal surface. *T. quadrilineatum*, p. 297.

bb. Body remarkably firm, cylindrical. (Oerstedia.)

1. Body slender, only 8 to 15 mm. in length; flesh color or yellowish, mottled, especially on dorsal surface, with brownish blotches and dots of various shades, often mainly collected into a series of transverse bands. . . *T. (Oerstedia) dorsale*, p. 299.
2. Body slender, 8 to 15 mm. in length; white, with large, rectangular and longitudinal, dark brown markings almost covering dorsal surface. Often with 16 pairs of rectangular marks and pair of lateral brown lines in addition to bilobed marking on dorsal surface of head. In some varieties markings fuse together. *T. (Oerstedia) reticulatum*, p. 300.

aa. Ocelli fragmented or wanting . . . . . **d.**

d. With four groups of fragmented ocelli.

1. Body usually less than 12 mm. in length; color pale yellow; 12 proboscidial nerves. *T. aberrans*, p. 293.

dd. Ocelli wanting; hermaphroditic.

1. Body 5 to 10 mm. in length; color whitish or very pale yellowish; probably parasitic, perhaps in Tunicates. . . . . *T. caecum*, p. 302.

FF. Proboscis sheath provided with caecal appendages; proboscis armed with central plate bearing a number of stylets, besides several pouches of accessory stylets. DREPANOPHORUS, p. 283.

1. Ocelli numerous, of very large size; length of body 5 to 10 cm.; color of dorsal surface dull reddish or orange, thickly covered with fine brownish dots; ventral surface flesh color with tinge of orange. . . . . . . *D. ritteri*, p. 283.

EE. Proboscis without stylet; intestine dendrocoelous; pelagic; body without external appendages. . PLANKTONEMERTES, p. 304.

1. Body broad, much flattened, gelatinous and hyaline; intestinal diverticula numerous; median dorsal vessel present; length 14 to 47 mm.; color orange or pink . . . *P. agassizii*, p. 304.

EEE. Proboscis without stylets; body provided with a pair of cirriform appendages in nuchal region. . NECTONEMERTES, p. 306.

BDELLONEMERTEA.

Sucking disk present at posterior end of body; intestine coiled, without caecum or lateral diverticula; parasitic in various species of Pelecypods. MALACOBDELLA, p. 305.

SYSTEMATIC ACCOUNT OF THE GENERA AND SPECIES WITH DESCRIPTIONS OF NEW SPECIES.

Carinella Johnston.

Mag. Nat. Hist. London, **6**, p. 232, 1833.

The species belonging to this genus are characterized by a slender, soft, rounded body, capable of extending and contracting to a remarkable degree. Head distinctly marked off from body, usually much broader than parts immediately following, often flattened dorso-ventrally, and disk-like.

On each side of body a transverse furrow separates the head from

the esophageal region. Proboscis opening subterminal; mouth a small round opening on ventral surface just back of lateral transverse furrows. The lateral nerves lie outside the muscular layers of the body and just beneath the basement layer of the integument. The body walls are made up of a very thick outer epithelium with abundant glands, a basement layer, a circular muscular layer, and a longitudinal muscular layer in the order named, from without inwards. In addition to these there is, in the esophageal region, an inner circular muscular layer which often forms a dorsal, and sometimes a ventral crossing with the fibers of the outer circular muscular layer.

Proboscis sheath usually not more than one third the length of body. Proboscis small and short. Ocelli wanting. Cerebral sense organs usually represented simply by a pair of sensory pits in the epithelium, although some species (cf. *C. rubra*) possess a pair of well developed sense organs with ciliated canal, ganglion cells and glands. A pair of peculiar lateral sense organs is usually situated well back in the esophageal region. Some of the species show elaborate markings of fine white lines on a brownish body, others are homogeneous in color. Most species are colored in some shade of brown or red; some are bright vermilion and others milk-white.

Of this genus seven species are now known to occur in the region included in this report, only one of which (*C. pellucida*) has been found in other portions of the world. Three of these forms are known only from California, while the other four occur both in California and Alaska.

1. Carinella rubra Griffin.

Ann. New York Acad. Sci., **11**, p. 203, 1898.

Carinella speciosa Coe. Proc. Washington Acad. Sci., **3**, p. 11, Pl. 3, fig. 6; Pl. 9, figs. 1–3; Pl. 10, figs. 1, 2, 1901. Harriman Alaska Expedition, **11**, p. 11, 1904.

Carinella rubra Coe. Harriman Alaska Expedition, **11**, p. 115, 1904.

Pl. **1**, fig. 1; Text-figs. 2, 14, 24.

This species, which is the largest and most brilliantly colored of any which have been described in the genus, is represented by

numerous specimens from Alaska and Puget Sound, and by a colored drawing by Griffin of a specimen obtained at Sitka, Alaska.

It may be distinguished from the other described species of the coast by its soft and pliable body, capable of very great extension, by its broad, rounded head, and by its bright red, bright orange yellow, or deep vermilion color (Pl. 1, fig. 1). In alcohol the color becomes dull gray or brownish yellow, with a conspicuous brownish band in esophageal region.

Their great size — being upwards of 3 meters in length when fully extended — and brilliant coloring give the worms a most striking appearance. Such a worm when seen crawling in long and graceful curves over the bottom in clear water earns for itself a place among the most beautiful of all marine invertebrates.

The external characters and internal anatomy of this species have already been described and figured elsewhere (Coe, :01), and but few new points have been made out from the study of additional series of sections.

Cephalic glands are very highly developed (Text-fig. 2), in one specimen extending posteriorly far beyond the mouth. Here the masses of glands mostly lie directly dorsal to the lateral blood vessels and communicate with the dorso-lateral surfaces of the body at frequent intervals.

The *rhynchocoel vessels* lie in the muscular walls of the proboscis sheath, connect at frequent intervals with the lateral blood vessels, and frequently press inward to lie close beneath the epithelium of the rhynchocoel. The vessels do not project into the lumen of the rhynchocoel, however, as they do in *C. sexlineata* and some other species of the genus.

The *nephridial canals* are provided with a complex tangle of minute tubules — nephridial gland — lying on the external lateral faces of the lateral blood lacunae, in addition to the large longitudinal vessels (Text-fig. 14).

Cerebral sense organs highly developed, with distinct ciliated canals (Text-fig. 24).

Sexual products are mature in July and August.

Habitat. — I have examined one specimen of this species collected at Albert's Head, Vancouver Island, by Mr. C. Shearer. Another fine specimen was sent me from Pacific Grove, Cal., collected at low-water by Mr. A. J. Carlson of Stanford University. Represented

in the Albatross collections by a portion of one individual about 30 cm. in length from Beaver Harbor, B. C. The species has been previously recorded from Puget Sound and from Sitka, Alaska (Griffin, '**98**), and from Sitka, Prince William Sound, Dutch Harbor, and Unalaska Island, Alaska (Coe, :**01**). Its known range is therefore from Monterey Bay, California, to Puget Sound, along the coast of Alaska to the Aleutian Islands — a distance of about 2600 miles. It occurs under stones, among sea-weeds, and in crevices of rocks, but in none of the localities mentioned is it a common species.

2. Carinella sexlineata Griffin.

Ann. New York Acad. Sci., **11**, p. 201, 1898.

Carinella dinema Coe. Proc. Wash. Acad. Sci., **3**, p. 15, Pl. 1, figs. 2, 3, 1901. Harriman Alaska Expedition, **11**, p. 11, 1904.
Carinella sexlineata Coe. Harriman Alaska Expedition, **11**, p. 115, 1904.

Pl. **1**, figs. 2, 3 ; Pl. **15**, figs. 90–92.

The species is characterized by its deep brown color and number and arrangement of its narrow, white transverse and longitudinal lines. There are five distinct, parallel longitudinal lines and an indication of a sixth on the median ventral surface. Of the five distinct lines, one lies on the dorso-median surface, while the other four are placed symmetrically on the lateral margins, the two on each side being separated by an angle of about 45°.

As illustrated by Pl. **1**, figs. 2, 3, the six longitudinal white lines so characteristic of this species most commonly consist of rows of minute isolated white dots, rather than continuous lines of color. These dots may be so closely placed, however, as to give the appearance of continuous lines in one portion of the body, and of rows of dots in other portions. The distance separating the individual dots is liable to the greatest variation, but the pattern is always constant. Occasionally the median ventral line is quite conspicuous between the second and fourth transverse rings, but is usually merely indicated by a row of scattered white dots.

A series of narrow white rings encircle the body at fairly regular intervals throughout its whole length. There are often 150 or more

such rings, although many are interrupted on ventral surface, and many others consist of very fine double lines.[1]

In one individual collected at Monterey the white rings in the middle portions of the body were practically as wide as the brown surfaces between them, so that the general color effect in this portion of the body was grayish instead of the usual brown color.

The worms live in thin, but tough, translucent tubes, which they secrete about their bodies. Such tubes are open at both ends, and are often secreted when the worms are kept alive in an aquarium.

To the anatomical descriptions already published (Coe, :**01**), the following additional peculiarities of internal structures, based on the study of several additional series of sections, prepared by Mr. Griffin, may be given.

Body walls.— Epithelium of body very thick, with closely packed deep seated glands. The two circular muscular layers of the body wall are without crossings, except in a limited area in, and immediately posterior to, the nephridial region. In this area the dorsal crossings are quite conspicuous, but the ventral are but faintly indicated. The internal circular muscular layer reaches a considerable thickness in the anterior nephridial region (Pl. **15**, fig. 92), but diminishes in front of the nephridiopores. In the region of the nephridiopores the longitudinal musculature is partially split up into a thick outer layer and a thin inner layer lying immediately external to the circular muscles about the esophagus. These two layers are separated laterally, and to some extent ventrally, by the gelatinous tissue of the body cavity (Pl. **15**, fig. 92). A band of longitudinal muscles lies between esophagus and proboscis sheath in nephridial region. The proboscis remains attached to its sheath for a very short distance behind the brain region.

Cephalic glands are absent among the tissues of the head. There is a very thick layer of deeply staining glands, however, about the rhynchodaeum, but these disappear completely in the brain region.

Blood vascular system.— The paired lacunae in the head are large, and reach nearly to anterior extremity. They are much dissected, even as far back as the mouth, by fibrous strands (Pl. **15**, fig. 90) which cross them in all directions. The ventral anastomosis near the mouth region is an unusually large lacuna. A pair of rhyn-

[1] For details see Coe, :**01**, p. 15.

chocoel vessels is present, but these are small in size, and do not extend far posteriorly.

Nephridia.— The nephridial canals are even shorter than in most related species, but show unusually well developed "nephridial glands" in the lateral walls of the lateral blood lacunae. The single pair of nephridiopores lie at the posterior ends of the canals and are situated on the dorso-lateral margins, as indicated in figure 91, Pl. 15. The efferent ducts are sometimes enormously swollen when passing through the circular muscles and basement membrane. From the efferent ducts a large convoluted canal passes forward for some distance without diverticula. It eventually turns backward and gives off several branches which subdivide to form the "nephridial gland." The main canal lies dorsally to the lateral blood vessel, and well separated from it. The nephridial gland is made up of a mass of minute tubules lined with a flattened epithelium and projecting slightly into the lumen of the lateral blood lacuna along its lateral border (Pl. 15, fig. 92). The general structure is very similar to that found in CARINOMA and CARININA. The larger nephridial canals and the efferent ducts are lined with columnar ciliated cells as in other species. The nephridiopores are situated very near the *anterior* end of the lateral sense organs (Pl. 15, fig. 91), so that it is only in a very few sections that both the nephridial canal and sense organs both appear.

Nervous system.— The brain lobes, dorsal median nerve, buccal nerves, and proboscis nerves are as in other species of the genus. The latter come off very abruptly from the internal border of the ventral ganglia, as Bürger ('95, Pl. 11, fig. 3) figures for *C. polymorpha.*

Sense organs.— The cerebral sense organs are well developed. They consist of a pair of sharply demarcated pits reaching inward to the basal layer of the epithelium (Pl. 15, fig. 90), and are situated just opposite the posterior ends of the dorsal brain lobes. The pits are lined with small, slender, ciliated cells, and are innervated by fibers passing from the posterior ends of the dorsal brain lobes, from which they are separated by the thin basement membrane only. Just dorsal to the sensory pits lies a pair of oblique, shallow, lateral grooves, the epithelium of which is clearly distinguished from that of the surrounding parts by being very much thinner and lacking the thick mass of gland cells. These lateral grooves are wholly

epithelial, and do not affect the even contour of the underlying basement membrane (Pl. 15, fig. 91).

The lateral sense organs are likewise very highly developed. They are indicated externally by a pair of rounded pits lying in, or just anterior to, the fifth white ring and immediately below the dorsal of the two white longitudinal lines on each side. The sense organs are sharply distinct from the surrounding epithelium. They lie just dorsal to the lateral nerves, and immediately external to the basement membrane. The slender epithelial cells of which they are composed are scarcely one third as high as the surrounding epithelium, and although there are very numerous gland cells in their basal portions, yet these glands are minute in size, and not conspicuous. The surrounding epithelium overlaps the sense organs considerably, but is separated by narrow infoldings or constrictions reaching inward nearly to the basement membrane (Pl. 15, fig. 91). Numerous nerve fibers pass directly to the sense organs from the lateral nerves, as Bürger ('95) has so fully described for other species of the genus. Muscular fibers extend to all parts of the sense organ, so that it is capable of considerable independent motion and may be depressed or elevated at the control of the animal.

Habitat.— The species is widely distributed, having been collected at Sitka, Alaska, and Puget Sound, both by Griffin ('98) and Coe (:01). It is common on piles of wharves at Monterey and at San Pedro, Cal., living in twisted, parchment-like tubes. Some individuals collected were no more than 75 mm. in length, while others were more than a meter when fully extended. The average size of numerous specimens collected in California in 1901 was about 20 cm.

3. Carinella capistrata Coe.

Proc. Washington Acad. Sci., 3, p. 16, Pl. 1, fig. 1, 1901.

Carinella capistrata Coe. Harriman Alaska Expedition, 11, pp. 16, 118, Pl. 1, fig. 1, 1904.

In shape, size, color and markings of body resembling *C. superba* somewhat closely, but may readily be distinguished by the absence of a median, ventral white line. Markings on head and arrangement of anterior white rings distinguish it from *C. annulata* and *C. nothus*. Arrangement of markings is likewise different from that in *C. sexline-*

ata and *C. cingulata* found in the same locality, for the former differs in having two white lines on each lateral margin, and the latter in having two lateral and two dorso-lateral white lines. *C. capistrata*, however, has but three longitudinal white lines, of which one lies in the median dorsal line and one on each lateral margin. As many as 200 narrow white rings often encircle the body; of these the most anterior ring is incomplete and V-shaped and extends ventrally only as far as the lateral margins of body. Anterior and lateral margins of head bordered by a narrow band of lighter color. Body very slender, sometimes a meter or more in length.

Lateral sense organs situated in the third white ring, as in *C. superba*.

In alcoholic specimens the body back of second white ring becomes very dark brown or nearly black, gradually shading posteriorly to pale brown.

Habitat.— Living in fragile, twisted, grayish, paper-like tubes beneath stones; abundant at Orca and Virgin Bay, Prince William Sound, Alaska (Coe, :01). Monterey Bay, California, one specimen collected by Professor Wilson in 1899.

4. Carinella frenata Coe.

Harriman Alaska Expedition, **11**, p. 129, Pl. 15, figs. 5, 6; Pl. 22, figs. 2, 3, 1904.

Text-figs. 5, 25, 26.

This species differs from any other described form of the genus in general color of body and arrangement of markings as well as in a number of anatomical peculiarities. The more striking features of external appearance and internal anatomy are as follows:—

Body rather firm, moderately slender; head broader than body, rounded or emarginate in front, much flattened dorso-ventrally, sharply marked off from body by deep, lateral, transverse grooves; proboscis pore and mouth as in related species.

Length of body, 50 cm. or more; width 2–3 mm.

Color.— General color of body usually cream yellow or ochre in anterior third; sage green in intestinal region, or dull rose or flesh color posteriorly when filled with mature ova. Body marked with a series of remarkably sharp, deep brown, transverse and longitudinal

lines and bands. Longitudinal lines three in number, very distinct, dark brown or black, extending throughout length of body, except on head. Lines placed symmetrically on body, one in dorso-median line; other two placed on or a little beneath lateral margins. Markings often have a velvety lustre, and in some lights appear iridescent or show a rich, dark blue reflection. Median line much broader than the others; it extends forward to extreme tip of snout, joining narrow transverse terminal line of same color. Longitudinal lines continue through transverse bands, or rings, usually expanding a little as the rings are joined. Median line occupies perhaps one seventh the diameter of body in intestinal region.

Lateral, or marginal, lines commence at the broad neck band (the first transverse band). Lateral lines scarcely more than one third as wide as median line, but yet sharp and clear cut in anterior portion of body, becoming more irregular in outline in intestinal region. On anterior third of body longitudinal lines are situated directly in the yellow ground color, but in intestinal region the median line is separated from the rose colored ground color of the mature females by an irregular border of sage green thickly flecked with whitish dots. Green color probably represents the general ground color when sexual products are absent; rose color is apparently due to thickly placed sacs of rose colored ova.

Transverse markings very numerous and of various widths; first two bands more than half as wide as body, those back of fourth much narrower, becoming extremely fine in some cases and incomplete in others. Wider bands commonly separated by one or two much finer ones. First transverse marking narrow, bordering extreme tip of head, distinctly visible only from in front. Second transverse marking broad and shield-shaped on dorsal surface, narrower laterally, interrupted on the ventral surface by mouth. Perhaps seventy to one hundred transverse bands occur in an individual measuring 50 cm. in length.

Ventral surface anteriorly of same color as dorsal surface, but showing a more conspicuous flecking of minute whitish dots. In intestinal region yellow color gradually assumes a shade of sage green or very light olive green, this color extending through to end of body. Green color is more or less obscured by an irregular coating of very fine whitish dots.

After preservation in formalin or in alcohol the portion of body

situated immediately posterior to third black ring becomes deep slaty blue or blackish in color. This dark shade is sharply demarcated anteriorly, fading out gradually after extending about as far as the ninth ring. Markings are retained even in cedar oil and in paraffin.

Cephalic glands but little developed, appearing only as scattered gland cells lying beneath and beside rhynchodaeum. Glands about rhynchodaeum few ; not extending back to brain.

Pigment of characteristic transverse and longitudinal dark markings situated deep in integument, distinctly visible in prepared sections.

Proboscis small, yellowish or ochre in color. Proboscis sheath well developed but not extending backward behind anterior third of intestinal region. Cavity of proboscis sheath becomes divided in exact region of the efferent nephridial ducts, forming a small chamber, situated dorsally, in which retractor muscle is attached, and a very much larger ventral chamber which passes backward for a short distance and ends in a broad blind sac (Text-fig. 5). Retractor muscle attached to the dorsal wall of dorsal chamber a little distance back in intestinal region.

Body musculature.— Inner circular layer much thickened immediately in front of nephridial openings, disappearing almost entirely at beginning of intestinal region. The circular muscles of proboscis sheath similarly increased in strength in same region but directly continuous with inner circular muscles of body wall. These thickenings correspond in nature and position with the enormously developed internal circular muscles in Carinoma and Carinomella.

Blood system.— The pair of rhynchocoel vessels extend from near the mouth back nearly half way to intestinal region, being connected with lateral vessels at frequent intervals. Walls of rhynchocoel vessels thickened, much convoluted, and apparently glandular in nature.

Nephridia.— Nephridial tubules limited to third quarter of esophageal region. Each of the two main longitudinal canals large, situated in parenchyma immediately above lateral vessels, swelling out at posterior end to form a large sac which sends off a large efferent duct to the dorso-lateral aspect of body (Text-fig. 5).

Sense organs.— Cerebral sense organs well developed for the genus, although not sharply separated from the other nervous

tissues. A distinct ciliated canal lined with sensory epithelium leads from a slight papilla in the specialized lateral cephalic furrow beneath the basement membrane and outer fibrous layer to the nervous tissues above and beside dorsal brain lobe (Text-fig. 25).

Lateral sense organs situated immediately behind efferent nephridial ducts, rather conspicuous in life, appearing as colorless, oval spaces in the midst of the lateral, longitudinal black lines, and at anterior border of fourth transverse band. Sense organs not very extensive, but highly specialized and very conspicuous in prepared sections (Text-fig. 26). Sensory cells less than half as high as those of neighboring cells of the integument, forming a conspicuous oval depression exactly on lateral margin.

Reproductive organs.— Sexual products mature in August, Eggs opaque and rose colored, giving characteristic rose coloring to bodies of females. They develop in pouches in the parenchyma above lateral nerves, each pouch containing upward of 20–50 or more ova. Oviducts open on dorso-lateral surface, completely formed some time before the eggs are deposited; lined with a distinct layer of small, closely placed epithelial cells. Genital sacs for following year established before eggs of previous year are fully mature.

Habitat.— Several feet below low-water mark on piles of wharf. San Pedro, California. Not common. Only sexually mature females were obtained (Coe, :**01**).

5. Carinella albocincta Coe.

Harriman Alaska Expedition, **11**, p. 136, Pl. 17, figs. 4, 5, 1904.

Pl. **1**, fig. 4.

This strikingly colored species with its characteristic markings may be distinguished easily from other described species of the genus by the following peculiarities:

Body rather stout for genus, not much flattened, rather firm; head of moderate proportions, of variable shape, broader than neck, demarcated from body by lateral constrictions; esophageal region rounded, intestinal region not much flattened, posterior extremity not slender; proboscis pore subterminal, proboscis rather small; mouth situated just back of lateral constrictions.

Size.— Usually 10–30 cm. in length; 2–4 mm. in diameter.

Color.— General color of body beautiful cherry red, sometimes inclining to brick red or purplish red, with a series of narrow, pure white rings usually completely encircling the body (Pl. 1, fig. 4). Rings all very narrow, hardly thicker than a thread; some much finer than others and merely indicated as very delicate hair lines. Large individuals possess 50 to 100 or more such rings, placed at varying intervals throughout length of body.

Tip of snout provided with a narrow, terminal border of white, fully as conspicuous from ventral surface as from above. When head is extended and obtusely pointed, white marking is angular and extends back on the lateral margins for about half the length of head. When head is contracted strongly the terminal white border appears merely as a short, transverse marking on each side of proboscis pore. First white ring lies in the constricted neck portion, being interrupted by the mouth and therefore incomplete ventrally. Second ring commonly separated from first by two to three times the width of body; more posterior rings separated from each other by an average distance of a little less than diameter of body in moderate extension; distance of separation depending largely on the state of contraction of body, varying fully four fold in different states of contraction. Rings often thinner ventrally than above; sometimes extremely fine, sometimes of double lines separated by a very thin line of the red color of body.

Ventral surface of a lighter shade than dorsal, and with a grayish tinge.

Color after preservation in formalin or alcohol dull reddish brown or purplish, with very faint white rings, and with abrupt change in color at the second white ring, the parts anterior being brownish, while those immediately behind the ring are deep purple. White terminal cephalic border remains conspicuous when body is not strongly contracted.

In internal anatomy the species presents few deviations from that described for related species of the genus.

Cephalic glands voluminous, occupying a great portion of tissues of head in front of brain.

Nephridia.— Excretory tubules limited to third and fourth fifths of esophageal region; with several profusely branching tubules anteriorly which unite farther back into about five to eight longitudinal

canals, situated above lateral blood lacunae; all these unite at posterior ends to form a rather large lacuna on each side, from dorsal wall of which the efferent duct leads to dorso-lateral aspect of body.

Sense organs.— Cerebral and lateral sense organs less highly specialized than in any of the other species of the genus described from the Pacific coast.

Habitat. — Rather common in 50–100 fathoms between San Pedro and Catalina Island, California. The worms live among red algae, with which they agree so perfectly in color that they are not easily discovered among the contents of the trawl. They are found associated with *Taeniosoma punnetti*, and exhibit a similar tenacity of life, being able to live for a day or more among damp seaweeds.

6. **Carinella cingulata** Coe.

Harriman Alaska Expedition, **11**, p. 138, Pl. 14, figs. 2–4, 1904.

This species is at present known only from Monterey Bay, California. It resembles *C. sexlineata* and *C. capistrata*, which are also found on the California coast, in shape of body and general appearance, and has a similar coloration. The markings on body, however, are arranged in a very characteristic manner and differ from those of any known species.

Head considerably broader than neck, rounded, truncate or emarginate in front, flattened dorso-ventrally, marked off from body by a distinct annular constriction; body often constricted in the annular white lines described below.

Length 15 cm. or more; width about 3–4 mm.

Color.— General tone of body deep brown, chocolate, or cinnamon brown; pale brownish posteriorly when filled with ripe genital products. Head paler than body, with a narrow, transverse, dark marking on each side of tip of snout. A darker brown transverse marking about one fourth as wide as diameter of body forms an incomplete ring in the mouth region. Four longitudinal white bands extend with more or less distinctness throughout the length of the body. Two of these are situated symmetrically near the lateral margins of body, the other two dividing the dorsal surface into three equal parts. Lines all terminate anteriorly in the first white ring, which is situated immediately behind the dark nuchal band. White bands

on dorsal surface broaden out irregularly in intestinal region and encroach so greatly on general brown ground color as to limit it to a narrow median dorsal stripe and two other narrow brown stripes on lateral margins. When sexual products are mature, brown color of intestinal region becomes largely obscured, especially on ventral surface, by pouches of nearly white reproductive elements. At other seasons the white bands would doubtless appear narrower, and the brown color of intestinal region would be more pronounced.

Body divided transversely into unequal segments by a series of narrow white rings, situated at irregular intervals from head to posterior end of the body, as in *C. capistrata.* Rings usually very narrow, but often conspicuous by being bordered, sometimes on both sides, by fine brown rings which are continuous with the general ground color, but of a darker shade. Color of white markings appears as if applied in small confluent spots and not homogeneously.

Rings farthest apart anteriorly but fairly regular in position ; often interrupted and wanting on the ventral surface.

After preservation in formalin, the region between second and third white rings is much darker in color, as commonly occurs in the genus. Contrast in color very marked anteriorly, shading off gradually behind.

Proboscis.— Proboscis sheath extends only a short distance into intestinal region ; rhynchocoel becoming sharply divided in vicinity of nephridiopores into a smaller posterior cavity and an enlarged anterior chamber. Latter continues ventrally for a few sections as a blind sac beneath the smaller, dorsal cavity to which posterior end of proboscis is attached, as in *C. frenata.*

Cephalic glands fairly well developed around the rhynchodaeum, extending back nearly to brain, and very conspicuous from their deeply staining secretions. Condition is here intermediate between that found in *C. frenata*, where these glands occur in integument only, and *C. rubra*, where they occur not only in the integument and around the rhynchodaeum, but are thickly massed in the cephalic musculature as well.

Blood and nephridial systems.— Rhynchocoel vessels not found in anterior fourth of esophageal region and extend for only a short distance, exhibiting numerous connections with the lateral vessels and terminating posteriorly in front of the nephridial system. Nephridia of normal type for genus, with a main canal above lateral

blood vessel on each side but of very limited extent, occupying less than the middle third of esophageal region. The efferent duct, leading from a sac-like enlargement at the posterior end of main longitudinal canal to dorsal surface of body, spreads out in the external circular muscular layer into a broad, spongy mesh-work, from which a small duct leads to the surface.

Cerebral sense organs but little specialized, without ciliated canals, consisting simply of an oval region with differentiated sensory cells of smaller size and with longer cilia than elsewhere, and provided with rather large nerves from the adjacent dorsal ganglia. Cerebral sense organs differ but slightly in their histological features from the lateral sense organs, but the region is conspicuous because of the absence of deeply staining glands.

Lateral sense organs small, but very sharply defined; situated on lateral margins of body immediately posterior to nephridiopores, appearing in life as rounded pits of paler color exactly on margins of body on anterior border of third white ring; sensory epithelium made up of slender cells presenting a sharp contrast to neighboring cells of integument because of their comparative freedom from secretion.

Habitat.— Monterey Bay, California; apparently a rare species, occurring from low water to 15 fms. or more on soft bottom. Sexual products mature in September.

7. Carinella pellucida Coe.

Trans. Connecticut Acad. Sci., **9**, p. 515, 1895.

Body very slender, almost filiform when fully extended, rounded throughout, or slightly flattened posteriorly. Head rather broad, often emarginate in front, flattened dorso-ventrally and marked off from body by slight lateral constrictions rather less distinct than in related species of genus. Resembles *Carinella linearis* McIntosh rather closely externally, but differs in many respects in internal anatomy, as noted below. Resembles *Cephalothrix linearis* also in color, size and general shape of body, except head, but can readily be distinguished by position of mouth, by shape of head, and by the fact that it does not coil the body in a spiral.

After preservation a conspicuous brown or blackish band appears

on body in the middle portion of esophageal region. This is sharply demarcated anteriorly, but fades out gradually posteriorly as in other species of genus. It is usually twice as wide as the diameter of the body, and towards its posterior portion shows a clear, oval area on each lateral margin. These oval areas represent the lateral sense organs.

Size.— A minute species, commonly 10 to 25 mm. in length when sexually mature, and from less than 0.5 to 1 mm. in diameter.

Color.— Pure white and translucent in head and esophageal regions, changing to opaque white or cream color at beginning of intestinal region. Median dorsal and ventral bands of very pale yellow or slightly orange color sometimes appear in intestinal region of mature females filled with cream colored eggs.

Proboscis and proboscis sheath as in related species; not extending into posterior half of body.

Musculature.— Muscular crosses between the two circular muscular layers very little dveloped, except for a limited distance on dorsal side of body in nephridial region. Internal circular muscles very little developed, but become thicker in posterior nephridial region than elsewhere, and practically disappear immediately posterior to efferent nephridial ducts, as in *C. linearis* and certain other related species. The band of longitudinal muscles so massively developed in *C. linearis* and in CARINOMELLA (p. 136) between proboscis sheath and alimentary canal in posterior nephridial region is practically wanting in the present species.

Cephalic glands.— Integument of head very much thickened and provided with an abundance of deeply staining glands which apparently take the place of specialized cephalic glands, for these latter are entirely wanting, except for a thick layer of deeply staining glands closely bordering the rhynchodaeum.

Alimentary canal.— Mouth situated immediately behind slightly constricted posterior portion of head. Esophageal cavity divided into two distinct regions lined with specialized epithelium, as in CARINOMELLA. Anterior esophageal cavity extends to about the anterior end of nephridial region or to anterior end of brown band seen on surface of body after preservation. From this point back to the posterior end of nephridial region extends the posterior esophageal cavity, or stomach. The histological peculiarities of these two portions of the alimentary canal are similar to those described for CARINOMELLA (p. 137).

Nephridia.— Nephridial tubules extend anteriorly just about as far as anterior margin of dark band of integument, and are confined to a very short portion of the body. Anteriorly there are fine tubules which ramify on the external wall of each of the large lateral vessels, and encroach considerably on its lumen. The fine tubules are collected into a single longitudinal duct on each side, which passes posteriorly along the dorsal wall of the lateral vessel. This longitudinal duct is often nearly as large as the blood vessel itself when contracted, and after passing posteriorly for a comparatively short distance opens on the dorso-lateral surface of body by a large efferent duct.

Blood system.— The pair of very large cephalic lacunae are united anteriorly by a broad, median lacuna. Lateral vessels of large size, situated in esophageal region in the angle between esophagus and proboscis' sheath and often closely applied to the latter. Consequently special rhynchocoel vessels are very much reduced or completely wanting. At intervals, however, sieve-like diverticula from the lateral vessels pass partially or completely through the muscles of proboscis sheath and spread out beneath the inner epithelium of the latter. In the most anterior esophageal region lateral vessels lie internal to delicate inner circular muscles, but soon pass outside it. Esophageal lacunae referred to in a previous paper (Coe, '95[b], p. 517) probably exist only as artifacts, and do not appear in more recently prepared sections.

Nerves and sense organs.— Cephalic nerves well developed, as are also the esophageal and dorso-median nerves. Inner dorso-median nerve and ventral nerve much reduced. When body is much contracted lateral nerve cords are often forced out into the integument to some extent.

Cerebral sense organs little developed, and are represented merely by specialized epithelium in very slight grooves adjacent to dorsal brain lobes. In a previous paper these are erroneously referred to as "side organs" (Coe, '95[b], p. 517).

Lateral sense organs fairly well developed, but not as highly specialized as in *C. sexlineata* (p. 114), or in Carinomella (p. 142). Relative position of these sense organs and efferent nephridial ducts is somewhat varied. In some specimens the sense organs lie entirely in front of nephridiopores, while they sometimes extend beneath and sometimes a little behind the latter. As stated above,

the lateral sense organs are conspicuous in preserved specimens as a clear, oval area on each lateral margin of body in the midst of the dark band.

Reproductive organs. — Sexually mature in August and September. Sexual glands, as in other species of genus, closely packed together on dorsal side of body, but encroaching on the other tissues when fully mature so as to fill up most of the space within the body walls. Ova slightly cream colored.

Habitat. — Living in delicate, parchment-like, translucent tubes on piles of wharf, under stones and in sand, Monterey, San Pedro, and San Diego, Cal. The species is widely distributed as to situation, but was not found abundantly in any locality. It has previously been recorded from the Atlantic coast of the United States (Coe, '95 [b]), and is not uncommon near New Haven, Conn., and Woods Hole, Mass., at low water. It is also common among dead shells in 3 to 5 fms. in Vineyard Sound, Mass.

This form resembles *C. linearis* in many respects, but lacks the reddish coloring posteriorly and differs in many anatomical features, most conspicuously in the absence of the broad band of longitudinal muscles so massively developed in *C. linearis* (cf. Bürger, '95, Pl. XIII, fig. 21) between proboscis sheath and alimentary canal in posterior nephridial region.

Carinomella, gen. nov.

Body rather slender, rounded anteriorly, flattened in the intestinal region. Head changeable in shape, often wider than parts immediately following; pointed, rounded or emarginate in front, according to state of contraction. Proboscis pore ventral, near tip of snout; mouth immediately behind brain.

Cephalic furrows represented only by a pair of very inconspicuous transverse grooves just back of head. Cerebral sense organs wanting, but a pair of large and very highly developed lateral sense organs lies in the vicinity of the nephridial openings, as in CARINELLA. Ocelli wanting.

Intestine without regularly paired, lateral diverticula, although the epithelium is thrown into conspicuous folds which often simulate actual diverticula.

Body musculature consists of a strong longitudinal layer and two

circular layers. Of the latter the outer circular muscles remain very thin throughout the body, while the inner become massively developed in the nephridial region, back of which they terminate abruptly, except for a few delicate fibers which continue to the posterior end of the body. The longitudinal muscles are highly developed throughout the body. A very massive layer of longitudinal muscles lies between the proboscis sheath and intestinal canal. These muscles are thickest immediately behind the nephridia, and join the main longitudinal muscular layer posteriorly to the end of proboscis sheath. Proboscis sheath extends through about half the length of the body. Proboscis composed of two muscular layers — an inner circular and an outer longitudinal layer — outside or between which is a firm basement membrane or layer of connective tissue. Proboscis cavity separated into three chambers, of which the anterior is bulb-like in some states of contraction and resembles the middle chamber of the proboscis of some of the Hoplonemerteans, although it is without armature.

Nephridia much as in *Carinella linearis.* Blood vascular system consists of very large cephalic lacunae and a pair of large lateral vessels. These latter lie internal to the inner circular layer in the esophageal region; farther back they pass outside this layer and lie between it and the longitudinal muscles, while in the intestinal region they become imbedded in the longitudinal muscles.

Brain shaped much as in Carinella and similarly situated immediately beneath the basement layer of the integument. Lateral nerves likewise situated between the outer circular muscles and the basement membrane, although in the nephridial region, and throughout all the body more posteriorly, the nerves sink inward among the longitudinal muscles, carrying at least a portion of the very thin circular layer with them. By this means the nerve cords may come to lie well toward the inner border of the longitudinal muscles (Pl. 9, fig. 60), although still situated to some extent outside the very thin layer of circular muscles.

Sexual glands develop as small pouches lying in the longitudinal muscles on the dorsal side of the body.

This new genus is of especial interest in that it unites many of the characters of Carinoma with others that have been considered peculiar to the Carinellidae. The genus Carinomella furnishes a strong argument in support of Bergendal's recent contention (:00) that

the genera CARINELLA and CARINOMA are much more closely related than Bürger considers probable. I now believe that Bergendal was fully justified in restoring Hubrecht's order Paleonemertea to include the families Carinellidae, Hubrechtidae, Carinomidae and Cephalothricidae. Miss Thompson also agrees with him (:**02**, p. 732) in this classification. The present genus evidently belongs to the family Carinellidae, and shows a striking similarity to *Carinella linearis* McIntosh in many peculiarities of structure. The position of the lateral nerves in the midst of the longitudinal muscles behind the nephridial region only is a wide departure from any described genus. In this character the new genus suggests a close relationship with CARINOMA, as will be described below. The massive development of the inner circular muscle and its practical disappearance in exactly the same region as in CARINOMA represent the conditions found in that genus, although an approach to this condition is also found in certain species of CARINELLA, notably *C. linearis*.

The massive band of longitudinal muscles between the proboscis sheath and the intestinal canal, most highly developed posterior to the nephridial region; the position of the lateral blood spaces internal to the inner circular muscles in the anterior esophageal region; the pouch-like outfoldings of the intestine, which are not true diverticula, however; the structure of the proboscis; the enormous cephalic blood lacunae; the extremely thin basement membrane; the total absence of cerebral sense organs; the anastomosing fibers of the integument; these may be enumerated as some of the more striking peculiarities of the present genus.

With Bergendal's genus CALLINERA (:**00**) there are many similarities, but the differences are even more pronounced than is the case with CARINELLA.

8. **Carinomella lactea**, sp. nov.

Pl. **5**, figs. 45–49; Pl. **6**, figs. 50–54; Pl. **7**, figs. 55, 56; Pl. **8**, figs. 57, 58; Pl. **9**, figs. 59–61; Pl. **10**, figs. 63–65. Pl. **11**, figs. 66–62.

Body of rather small size, slender; rounded anteriorly, flattened in intestinal region. Head broad, variable in shape; pointed,

rounded, or emarginate according to state of contraction; often flattened dorso-ventrally and shovel-shaped; marked off from parts immediately following by a pair of faintly indicated lateral, transverse grooves. Ocelli wanting.

Color.— General color of the body milk white and more or less translucent throughout. This color is somewhat affected, however, by the intestinal canal which is often pale yellowish or sometimes brownish. In the brain region there is often a rosy tinge. The esophagus shows an anterior translucent portion, while its posterior half is opaque white. Proboscis is small; white in color.

After preservation in formalin or in alcohol, there is commonly a marked differentiation of color in the anterior portion of the body, perfectly similar to the well-known dark band which occurs in most species of Carinella after preservation. About 5 mm. of the anterior end of a medium-sized specimen is pure white, and this is followed by a sharply marked brownish or pale brick red band (Pl. 5, figs. 46, 47). This shades off gradually posteriorly, precisely as in Carinella, so that its exact width cannot be determined, but the brownish tinge is conspicuous for 2 mm. or more in a specimen which measures 20 mm. long and 1½ mm. wide after preservation. In serial sections the position of this band can easily be distinguished with the naked eye because of the differential staining of the integument where it is present. This effect is apparently produced by a differentiation in the chemical nature of the glandular secretions, and not to any special pigment. Anteriorly, where the color is deepest, the layer of peculiarly stained glands occupies the inner two thirds of the integument, but the layer becomes gradually thinner posteriorly, until there are only a few scattered glands at the beginning of the intestinal region. The band is of the same thickness ventrally as dorsally, and begins anteriorly near the forward end of the nephridial region.

The lateral sense organs are easily distinguished with a hand lens on preserved specimens. They lie on the lateral margins of the body near the posterior border of the reddish brown band, and each appears as an oval depression bordered with a white or colorless rim (Pl. 5, figs. 46, 47). Naturally the sense organs show most conspicuously in those specimens which have the brownish band of the deepest color. The body usually shows an annular constriction just posterior to the sense organs, due to contraction of the powerful circular muscles.

A dorsal, longitudinal infolding of the integument can also be distinguished in the same region. This infolding will be described below.

Size.— Length 50–100 mm.; width about 2 mm.

Proboscis sheath.— The rhynchodaeum is lined with columnar, glandular epithelium (Pl. 6, fig. 53) as far back as the attachment of the proboscis, while the most anterior portion of the proboscis has only flattened cells. These are soon replaced by columnar, glandular cells, as described below.

The proboscis sheath has a layer of circular muscles which remains rather thin throughout its length, except in the region of the great thickening of the inner circular muscles of the body walls, and here (Pl. 7, fig. 56; Pl. 8, fig. 57) the muscular fibers of the proboscis sheath increase correspondingly in strength.

Internal to the circular muscles is a thin layer of longitudinal muscles on which rests the thin epithelium of the rhynchocoel. Farther back this layer disappears, and the epithelium rests directly on the circular muscles. Outside these latter occurs a second layer of longitudinal fibers, much stronger than the inner layer, but not so intimately connected with the proboscis sheath. Anteriorly they are found only as two broad bands, one of which lies between the circular muscles of the sheath and the alimentary canal (Pl. 6, fig. 54), while the other lies above the sheath and separates its circular muscles from the inner circular layer of the body walls. A little farther back (Pl. 7, figs. 55, 56) the layer completely surrounds the circular muscles of the sheath, but remains thickest between the sheath and the alimentary canal.

Just at the end of the enormously thickened inner circular layer of the body walls the circular muscles of the sheath fuse dorsally with the few remaining fibers of the inner circular layer (Pl. 8, fig. 58). At the same place the longitudinal muscles disappear both dorsally and laterally, and become collected into a massive band (*lmp*) which lies between the sheath and the alimentary canal. This band of muscles is very characteristic, and is similar to that found in *Carinella linearis* and a few other species. It remains of great strength well back into the intestinal region, and is entirely separated from the longitudinal muscles of the body walls by the very thin inner circular layer. It extends to the posterior end of the proboscis sheath (Pl. 8, fig. 58; Pl. 9, fig. 59).

Posterior to the great thickening of the inner circular body muscles, the sheath is extremely thin and cannot be resolved into definite layers, its walls apparently consisting of a few circular fibers only.

As stated above, the sheath terminates posteriorly at about the middle of the body.

Proboscis.— As is the case with many of the other organs of the body, the proboscis of this remarkable worm presents peculiarities quite unlike those described for any other species. The most important of these is the bulb-like expansion (Pl. 5, figs. 47, 49) near the anterior end of the proboscis; this is followed by a constriction through which a narrow canal leads to the middle chamber which extends through the greater portion of the length of the organ. The histological features and musculature of the two chambers are quite different, as will be described below. A second peculiarity consists of a pair of strong muscular bands (Pl. 6, fig. 54) which originate among the tissues of the head near the attachment of the proboscis, but which, instead of entering the proboscis immediately, pass posteriorly for some little distance in the rhynchocoel and eventually enter the outer layers of the proboscis.

After passing through the thick basement layer of the proboscis, the muscular bands spread out to form the main longitudinal muscular layer of this organ. Anterior to the attachment of these two muscular strands, the proboscis is devoid of all muscles, being made up of a dense layer of homogeneous connective tissue with thin epithelial coverings both externally and internally (Pl. 6, fig. 54).

The proboscis is attached to the tissues of the head in the mouth region, the attachment sometimes appearing to lie a little anterior to the mouth but occasionally a little farther back, the relative position varying according to the state of contraction of the parts.

There are three distinct regions or chambers to the proboscis, as mentioned above. The most anterior chamber has very thin walls anteriorly, which thicken rapidly a little farther back. This chamber is very short and ends posteriorly in a bulb-like expansion, from which a narrow canal leads back to the middle chamber. Sometimes the bulb-like appearance is very marked; when but little contracted it is much less conspicuous. A section through the anterior chamber (P. 11, figs. 67, 68) shows a very thick inner layer of columnar glandular cells of two kinds, probably differentiated by the nature of their secretions. One variety (*gl'*) is finely granular and stains

bluish with haematoxylin-orange, while the other cells (*gl*) are thickly packed with minute vacuoles of secretion which take the orange stain with the same combination.

Beneath the epithelium is a thin layer of connective tissue in which the two large proboscis nerves are imbedded, and beneath this a thin layer of circular muscles. Next toward the periphery comes the thick layer of circular muscles, of very coarse fibers, and of several times the thickness of the circular layer. Outside the longitudinal muscles lies a layer of homogeneous, but tough and firm, connective tissue (*bm*) which shows no indication of fibers. This is a sort of basement layer, usually more than half as thick as both muscular layers, and is especially characteristic of the anterior chamber. I know of no other species of nemertean where this layer is so well developed. It gradually disappears at the posterior end of the anterior chamber, but reappears internal to the longitudinal muscle of the middle chamber. Outside the basement layer is the usual thin layer of flattened epithelium bathed in the fluid of the rhynchocoel.

At the posterior end of the anterior chamber the proboscis diminishes greatly in diameter, its lumen becoming reduced to a narrow canal which lies excentrically, but the circular muscles (Pl. **11**, fig. 69) become enormously increased. This canal is much twisted, and after a short distance opens into the middle chamber, with its wide lumen and very peculiar epithelial lining. The exact nature of this epithelium is very difficult to determine. The cells are columnar (Pl. **11**, fig. 66 *pep*), with homogeneous cytoplasm, and their oval nuclei arranged for the most part in two layers. One of these is situated near the base of the cells and the other well up toward the free border. Both the cells and their nuclei are very much smaller than those in the anterior chamber. Between the borders of the cells and the actual lumen of the proboscis are two layers of a somewhat uncertain nature. Apparently each columnar cell (Pl. **11**, fig. 66) bears a single well-developed flagellum (*fl*), which is perhaps three fourths as long as the cell, and which seems to end distally in a thick mass of opaque, granular secretion (*s*). This secretion forms a thick layer around the actual lumen of the proboscis. The two nerves lie in the basal portion of the epithelial layer (Pl. **11**, figs. 66, 71). The present evidence seems to indicate that this middle chamber represents a highly specialized, sensory portion of the pro

boscis, and that the darkly staining secretion was formed elsewhere and has accidentally lodged on the flagella of the sensory cells. This hypothesis is merely a tentative one, however.

The middle chamber extends backward about as far as the nephridial region, and is there succeeded by the posterior chamber, the epithelium of which is of the glandular type characteristic of the proboscis. In the posterior chamber occur also typical rhabdite cells. These are situated on one side of the lumen only, and are not very numerous. In form each rhabdite cell (Pl. **11**, fig. 72) is pyramidal, with the apex much elongated and bearing a single nucleus as usual. The base of the cell borders the lumen and bears a single layer of spindle-shaped rhabdites (*a*) to the number of perhaps 20 to 50 (Pl. **11**, fig. 72). The transition of the epithelium of the middle chamber into that of the posterior chamber is not abrupt, for the glandular and rhabdite cells only gradually replace those which bear the flagella.

The middle chamber has a rather thick layer of connective tissue (Pl. **11**, fig. 66, *ct*) and a homogeneous basement layer (*bm*), both of which lie between the circular and the longitudinal muscles. The connective-tissue layer is the more internal, and is provided with nuclei and delicate fibrils, while the basement layer which lies just internal to the longitudinal muscles is perfectly similar to that which was found external to the longitudinal muscles in the wall of the anterior chamber. In the posterior chamber the layer of connective tissue is wanting, while the homogeneous basement layer has again moved outside the longitudinal muscles and taken up a position immediately internal to the outer, flattened epithelial layer. The conditions are thus exactly as in the anterior portion, except that the basement layer is very much thinner. Toward the posterior end of the proboscis all the layers, except the glandular epithelium and longitudinal muscles, become so much reduced as to be hardly demonstrable.

Integument.— As in related genera, the integument is remarkably thick in proportion to the other layers in the anterior portions of the body. The relative thickness in different parts of the body is shown in Pl. **6**, figs. 53, 54, Pl. **7**, figs. 55, 56, Pl. **8**, figs. 57, 58, and Pl. **9**, figs. 59, 60. In the intestinal region the integument becomes decidedly thinner than more anteriorly, and it is usually conspicuously thicker on the dorsal than on the ventral surface of the body. The

epithelium consists of columnar ciliated and glandular cells as in related genera. The glandular cells are of two or more varieties, forming different kinds of secretions (Pl. 9, fig. 60). Certain cells, as in other species, form homogeneous, rodlike masses of apparently semisolid consistency, while others secrete a deeply staining granular substance. Interspersed among these are numerous clear, mucous cells.

Conspicuous among the epithelial cells when examined with high powers of the microscope are numerous extremely delicate fibers which pass from the underlying tissues through the basement membrane and ramify among the integumental cells. These delicate fibers are most numerous in the head and anterior esophageal regions, although they are found throughout the body. It seems not unlikely that a small portion of them are nerve fibers, and that they communicate peripherally with specialized sensory cells in the integument.

On the other hand, it can be readily demonstrated that the major portion of them are muscular fibers, for they can be followed through the basement layer and into the outer circular muscular layer where many of them undoubtedly originate. In favorable preparations certain of the fibers of the muscular layer can be seen to thus branch off to the integument. Such integumental fibers have been described for several other species of nemerteans, and are especially common in the Paleonemertea. It seems probable that from some such loose arrangement of fibers as is here found, the definite layers of integumental muscles of Carinoma and higher forms have been derived. In Carinoma a portion of the fibers are always loosely arranged.

The specialized epithelium of the contractile lateral sense organs will be considered below (p. 142).

The differentiated portion of the integument which constitutes the dark, brownish band so conspicuous in preserved specimens, as described above (p. 128), exhibits the same peculiarities as the similar bands in Carinella. In all stained preparations the anterior line of demarcation of this band is sharply distinct. The peculiarities of the integument in this region are apparently due to a great abundance of specialized gland cells, which are situated among the ordinary integumental cells, and which form a secretion of such a chemical nature that it is in some way decomposed by the action of the pre-

serving agents, so as to produce the dark color in a worm which was whitish in life. In the anterior portion of the band, where the color is deepest, these gland cells are more closely placed (Pl. 7, fig. 56) and reach nearer the outer surface, but more posteriorly (Pl. 8, fig. 57) they gradually become more scattered and of smaller size. The band thus fades out gradually posteriorly, as described above, and as is well known in CARINELLA.

Body musculature.— The musculature of the body resembles that of CARINOMA in its general aspects, but differs in many particulars. It also resembles — perhaps even more closely — that of certain species of CARINELLA, notably *C. linearis.*

The main longitudinal muscular layer is well developed throughout the body. The circular layer outside this likewise continues throughout the length of the body, but is everywhere thin and inconspicuous. Between the longitudinal and the outer circular muscles a double set of diagonal muscles can be distinguished in the esophageal region, as in CARINOMA (Pl. 12, fig. 79). An internal circular layer extends throughout the esophageal region, reaching a great thickness and then suddenly almost disappearing at the beginning of the intestinal region, as in CARINOMA.

In the vicinity of the nephridiopores there is a marked infolding on the dorsal surface of the body, which presses the longitudinal muscles in the dorsal half of the body toward the lateral margins. In many cases the infolding is so marked as to bring the two circular layers into contact, so that for a short space immediately above the proboscis sheath the longitudinal muscles do not appear at all (Pl. 8, fig. 57). As described below, this infolding is caused by contraction of the fibrous crossings between the two circular muscular layers.

The inner circular muscle is very thin immediately behind the mouth, but increases rapidly in thickness throughout the esophageal region. It reaches its maximum thickness in the nephridial region, where it becomes from one half to two thirds as thick as the layer of longitudinal muscles. Immediately behind the nephridial region it disappears almost completely, although a few fibers continue to surround the proboscis sheath and intestine. Behind the posterior end of the proboscis sheath careful examination shows that this muscle still continues as a very delicate circular layer closely surrounding the intestine almost as far as the posterior end of the body.

The region of greatest thickening of these muscles is indicated in Pl. 8. fig. 57, *cm*.

For a short distance behind the mouth the lateral blood vessels, with their surrounding parenchyma (Pl. 6, fig. 54), lie inside the inner circular muscles, but somewhat farther back in the esophageal region they pass to the outside of these muscles, which now closely invest the proboscis sheath and esophagus, as is the case also in *Carinella linearis*. In CALLINERA, Bergendal (:00) finds the inner circular muscles to lie outside the lateral vessels both in the esophageal and anterior intestinal regions, but this condition is very unusual.

In connection with the inner circular muscles, it should be noted that in the esophageal region the nuclei of the muscle fibers are usually nearly all congregated in the immediate vicinity of the lateral blood spaces. Such a position is doubtless due to a more abundant nutrition near the blood vessels than elsewhere. This circular layer is also interrupted at intervals by outgrowths or diverticula of the lateral vessels immediately between the latter and the rhynchocoel. These appendages to the blood vessels also pierce the wall of the proboscis sheath to form the rhynchocoel vessels, as described below. They are not very numerous, however, posterior to the region where the lateral vessels pass outside the inner circular muscles.

As stated above, the two circular layers often come closely in contact immediately above the proboscis sheath in the region of the nephridiopores, and to these the circular muscles of the sheath itself are closely approximated. For a brief space, therefore, no other than circular muscles are encountered from the outside of the body to the rhynchocoel in the mid-dorsal line (Pl. 8, fig. 57).

The very delicate outer circular muscular layer is bordered externally by a thin basement layer, except in the position of the lateral and dorsal nerves which lie between the two layers throughout most of the body. In the nephridial region, however, the lateral nerves sink inward to the middle of the longitudinal muscular layer (Pl. 9, fig. 60), apparently carrying with them a portion of the circular muscular fibers. A few circular fibers, nevertheless, remain next the basement layer, and are thus widely separated from those which were carried inward by the lateral nerves.

The outer circular muscles are interrupted in the position of the lateral sense organs by a special set of muscles which originate in

the longitudinal layer, and which pass through the circular muscles to furnish special movement and contraction of the sense organ.

Delicate muscular crosses between the two circular muscular layers occur on both the dorsal and ventral sides of the body. The dorsal crossing is much the better developed and increases in strength from the mouth to the nephridial region. In the region of the nephridiopores this crossing becomes sufficiently strong to bring the two layers of circular muscles into contact, and thus cause a marked infolding of the dorsal surface of the body in the median line in this region (Pl. 8, fig. 57). This infolding can often be detected by means of a hand lens on the body of the worm. When the fibers of the crossings are less strongly contracted the infolding is naturally less than that shown in the drawing (Fig. 57). The dorsal crossing is very delicate in the intestinal region, although it can be traced throughout the whole extent of the body. The ventral crossing is much less marked, but it is easily recognized as far back as the nephridiopores. Posterior to this region it is only faintly indicated, and cannot be detected beyond the anterior portion of the intestinal region.

The very powerful band of longitudinal muscles which is so highly developed between the proboscis sheath and the alimentary canal posterior to the thickening of the internal circular muscles is very characteristic. It is so intimately connected with the proboscis sheath more anteriorly that its description will be found in connection with that of the proboscis sheath (p. 129). It is separated from the other longitudinal muscles of the body by the delicate internal circular muscles only (Pl. 8, fig. 58; Pl. 9, fig. 59). A somewhat similar muscle occurs in several species of Carinella, and is described by Bergendal (:00, p. 110) for Callinera, and (:04, p. 53) for Carinoma, where it is comparatively little developed, while in *Carinella linearis* the conditions are much as in the present species.

The basement layer is everywhere very thin, and in most instances is hardly to be distinguished from the outer circular muscles, except in the head and esophageal regions. Farther back the two layers together appear only as a single thin layer, except under the higher powers of the microscope. It is best developed in the brain region and becomes gradually thinner toward the posterior end of the body. It is also well developed in the vicinity of the lateral sense

organs. The basement layer is homogeneous, except as it is traversed by extremely delicate fibers which pass from the underlying layers to the integument.

The body parenchyma, or gelatinous tissue, is reduced to a minimum, being found only to a slight extent around the lateral blood vessels, nephridia, and the basal portions of the immature genital glands.

Cephalic glands are completely wanting as in most related species. The rhynchodaeum, however, is lined with a layer of columnar glandular cells. There are no other glands in the head beneath the integument.

Alimentary canal.— The mouth, situated immediately behind the brain, is of comparatively large size. In the living worm the esophagus can be seen to be divided into two distinct portions, the anterior of which is clearer and less opaque than the posterior. As shown in Pl. 5, figs. 47, 49, the mouth opens into a wide esophageal cavity which has smooth walls, and which continues backward about two thirds the distance to the brown band, or about half way from the mouth to the lateral sense organs. This esophageal cavity is lined with the usual columnar ciliated and glandular cells, the former being the more superficial and covered with numerous short cilia. The esophagus proper opens directly into a posterior esophageal cavity, or stomach (Pl. 5, fig. 47, *st*), which is considerably longer than the anterior cavity, and which is lined with a very different sort of epithelium. The line of demarcation between esophagus and stomach is indicated in Pl. 5, fig. 47, by the letters *e.o.*

Anteriorly the stomach cavity is of about the same diameter as the esophagus, but in the region of the thickening of the internal circular muscles (Pl. 5, fig. 47, *a*) it becomes reduced to a comparatively narrow tube, and posterior to these muscles enlarges again to more than its former diameter. Its walls are more or less folded and wrinkled, especially on the ventral side, where the epithelium is thicker than elsewhere (Pl. 7, fig. 55; Pl. 9, fig. 61). In longitudinal sections of the region posterior to the thickening of the circular muscles the ventral wall of the stomach appears to be thrown up into conspicuous folds (Pl. 9, fig. 61). These are not permanent pouches, however, but temporary folds of the epithelial lining only. When the body is extended these apparent pouches become much reduced or disappear completely. The same is true of the still more conspicuous intestinal folds.

The change from the esophageal epithelium to that of the stomach is very sharp, although it is accompanied by no change in the topography of the canal. The rather clear, ciliated cells of the esophagus proper give place to the peculiar granular cells — the cytoplasm of which is closely packed with minute vacuoles of secretion — so characteristic of the intestine. These are interspersed with very slender cells, each with a few cilia of greater length than are found in the esophagus. In the anterior portions the nuclei of the ciliated cells lie near the free borders of the cells, but farther posteriorly sink into their inner portions. The cilia in this posterior region are few, but of a length almost equal to that of the cell itself.

The folds in the ventral walls of the stomach become gradually more marked, and their lining of epithelium gradually differentiated to form the intestine proper. There is, therefore, no sharp line of demarcation between these two portions of the alimentary canal, either anatomically or histologically. In the intestine proper, which begins somewhat anterior to the sexual glands, the cells conform closely to the type described for other species, and are largely filled with the usual minute vacuoles of secretion.

The walls of the intestine are thrown up into conspicuous folds, with deep and slender pockets between them. Whether these pockets should be looked upon as permanent diverticula or merely as temporary depressions is somewhat uncertain. In transverse sections (Pl. 9, fig. 59; Pl. 10, fig. 63) it becomes evident that the depressions certainly do not correspond with the paired diverticula of Carinoma and the higher forms, for the epithelium of the central canal passes gradually into the deepest depressions, and there are no fibrous partitions between the pouches. A longitudinal section (Pl. 10, fig. 65) shows that the folds and their intervening depressions concern the epithelial lining only, and in no way affect the thin fibrous layer making up the wall of the canal outside the epithelium. The relation of the pouches is shown also in a tangential section (Pl. 10, fig. 64) through the distal portions of the pouches. This shows incipient secondary folds (*inf′*) between the principal ones.

The height of these epithelial folds of the intestine depends largely on the degree of contraction of the body, and would doubtless become largely obliterated if the body were stretched to its

utmost extent. The body is always more or less contracted when studied, and the folds are always present in preserved specimens, but it remains possible that when the worms are living and the body is in its fully extended condition the folds would entirely disappear. In certain parts of the body they are much higher than in others, and are also higher on the ventral than on the dorsal side (Pl. **10**, fig. 65).

Where the genital pouches are fully developed they encroach to some extent on the intestinal space, and there is sometimes an indication of an alternation between the sexual pouches and the intestinal folds, but the relation is merely superficial.

Nephridia.— The nephridial tubules are limited to a short space about midway between the head and anterior sexual glands. This can hardly be called the esophageal, but is more properly the stomach region, as stated above. The usual delicate nephridial tubules form a sort of primitive "nephridial gland" by entering into close relation with the outer, ventral wall of the lateral blood vessels. As in Carinoma and Carinella, there are numerous fine tubules which press inward, causing corresponding infoldings in the wall of the blood vessel (Pl. **5**, fig. 48, *a*). The nephridial tubules extend forward nearly to the anterior border of the dark band seen on the body in preserved specimens and reach backward only about half-way to the end of the thickening of the circular muscle, and as far as the anterior ends of the lateral sense organs. Their extent is, therefore, remarkably limited. On each side at about the middle of the region of the nephridial tubules a single large duct (Pl. **5**, fig. 48) passes off and extends posteriorly on the dorsal side of the blood vessel (Pl. **7**, fig. 56) almost as far as the end of the thickening of the circular muscle. It then bends obliquely dorsally to open on the dorso-lateral surface of the body as usual. In its middle portions the main nephridial duct is larger than the core of the lateral nerve, but is much smaller toward its posterior opening. The diagram (Pl. **5**, fig. 48) will illustrate these conditions.

Blood vascular system.— The blood system consists principally of large cephalic lacunae and a single pair of lateral vessels with outgrowths into the wall of the rhynchocoel. It is, therefore, very similar to that of Carinella. The cephalic blood spaces are remarkably large, and more or less subdivided into numerous connected chambers by strands of connective tissue and muscle which pass

obliquely and dorso-ventrally through the blood spaces (Pl. 6, fig. 53). They surround the rhynchodaeum on every side, so that this organ is held in place in the midst of the blood spaces by comparatively thin strands of tissue only. In the brain region they unite into a pair of lacunae, which continue backward through the esophageal region as the lateral vessels. These vessels are large and thin-walled throughout the esophageal region proper and lie *internal* to the inner circular muscular layer (Pl. 6, fig. 54), but pass outside this muscle anterior to the nephridial region (Pl. 7, figs. 55, 56). In this respect the species is like *Carinella linearis*. Shortly behind the nephridial region the lateral vessels acquire muscular walls and are strongly contracted at intervals. In a contracted condition they appear to be surrounded by more parenchyma than is the case when they are distended (Pl. 9, fig. 59). Throughout the intestinal region they lie immediately beside the intestine and beneath the sexual glands.

In the posterior esophageal region occasional diverticula of the lateral vessels pass internally through the wall of the adjacent proboscis sheath, and apparently spread out somewhat beneath the epithelium of the latter, as has been described for Carinella. There are few of these diverticula, however, and they are without regularity of arrangement. They appear rather like a spongy network (Pl. 7, fig. 55) with minute spaces than like definite vessels. Posterior to the region where the lateral vessels pass outside the inner circular muscles are a few similar diverticular of the blood vessels, and these pass through both the inner circular muscles and the wall of the proboscis sheath. For a very short distance the diverticula form a pair of rhynchocoel vessels, much like those in Carinoma but less conspicuous.

Nervous system and sense organs. — The nervous system is much as in Carinella. Brain and lateral nerves are situated immediately outside the thin outer circular muscular layer, except for a short distance behind the nephridial region, where they sink inward to the midst of the longitudinal muscles, much as in Carinoma. As will be described below, they probably carry beneath them a portion of the circular muscles, however. The brain is of fairly large size, with well developed dorsal ganglia. The ganglia of the two sides are widely separated as in related genera, and the dorsal and ventral commissures pass directly beneath the basement layer as usual.

There are no indications whatever of cerebral sense organs, as is attested by several perfect series of sections. External to the brain and lateral nerves the basement layer, which is elsewhere extremely thin and inconspicuous, is comparatively well developed.

Anterior to the brain are numerous cephalic nerves (Pl. 6, fig. 53), which pass forward between the basement layer and the thin circular muscles as in some species of CARINELLA. In the nephridial region the lateral nerves press closely against the outer circular muscles which here bend inward to encroach on the longitudinal muscular layer (Pl. 8, fig. 57). The fibrous core now lies close against the muscles, while its sheath of cellular elements is situated peripherally, and between the nerve core and the basement layer. Behind the nephridial region, or the region of the thickening of the inner circular muscles, the nerve core sinks fully half way through the layer of longitudinal muscles which here closely surround it on three sides (Pl. 9, fig. 60). On the outer side alone are the cellular elements and sheath.

A transverse section through this region (Pl. 8, fig. 58) is strikingly like a similar section through CARINOMA so far as the muscular and nervous layers are concerned. It can be demonstrated, however, that a few delicate fibers from the outer circular muscles bend inward and continue to lie actually internally to the nerve core (Pl. 9, fig. 60).

In the intestinal region the nerve core again approaches the basement layer, and the cellular elements of the sheath lie both dorsal and ventral to it (Pl. 10, fig. 63). It has plainly regained its position between the outer circular muscles and the basement layer.

The explanation for such an inward migration of the nerve cords in a limited portion of the body is not immediately apparent. Such a change of position can hardly be due to the influence of mechanical stresses. It represents perhaps a case of arrested migration of the nerve cords, which in CARINOMA have assumed a similar position throughout the body.

The proboscis nerves are as in related genera; the pair of esophageal nerves is well developed, as are also the upper and lower dorsomedian nerves as far back as the thickening of the inner circular muscles. The median nerve found beneath the esophagus is fairly conspicuous anteriorly, but none of these nerves deserves special comment.

The lateral sense organs are remarkably highly specialized and provided with a special musculature. This musculature consists of a dorsal and a ventral band of fibers from the longitudinal muscles. These pass obliquely above and below the nerve cord respectively, and are nearly as large as the nerve core itself (Pl. 7, fig. 56). They spread out in a fan-shaped fashion among the sensory epithelial cells.

The sense organs are situated near the posterior end of the reddish brown band seen in specimens after preservation, where they are conspicuous because of their lack of color. Each sense organ is situated exactly on the lateral margin of the body a short distance in front of the nephridiopores. They appear as crater-like depressions with steep walls, and are capable of considerable independent movement in life.

The sensory cells lining the sense organ are small, slender, provided with long cilia, and are sharply differentiated from the surrounding epithelium by their lack of those deeply-staining gland cells, which are elsewhere very abundant in this region of the body. There are numerous other gland cells, however, of a very different nature and having peculiar staining properties, being only pale blue with haematoxylin and orange. The nervous supply for the sense organs comes directly from the underlying lateral nerves. In the region of the sense organs the outer circular muscular layer is interrupted, so that the lateral nerves lie among oblique and longitudinal muscles situated immediately beneath the sense organs.

Reproductive organs.— The sexual glands develop in the small amount of parenchyma above the lateral vessels, and when fully matured encroach upon the longitudinal muscles in the dorsal half of the body. They are scattered irregularly, although they appear to lie in pairs anteriorly (Pl. 5, fig. 47). When mature, they are closely packed together in a single row above the lateral blood vessel on each side, and extend quite through the longitudinal muscular layer (Pl. 10, figs. 63, 65). Their ducts open directly on the dorsolateral aspects of the body (Pl. 9, fig. 59). Sexual products are nearly mature in August.

Parasites.— Two of the specimens sectioned had in the intestinal canal thousands of gregarines, which were well preserved and beautifully stained. Other, and larger parasites, in the ova showed division into 16 or more oval bodies, and these may possibly represent a stage in the life history of the intestinal gregarine.

Habitat.— Common in rather sandy locations on the flats in San Pedro Harbor, California, from half-tide to low water. Also under stones at Dead Man's Island, San Pedro. The species is often associated with a small white species of CARINOMA (*C. mutabilis*), which it so closely resembles in size and color in life as to be easily mistaken by a merely superficial examination. The presence of distinct intestinal diverticula and the broad and flattened posterior extremity of the latter genus, however, will serve to distinguish it. After preservation the reddish brown band which appears in CARINOMELLA renders the identification very easy. A white CARINELLA (*C. pellucida*) has been collected in the same locality, but this is always minute in size and very slender. A whitish ZYGEUPOLIA (*Z. littoralis*) is also found at San Pedro, but this may easily be recognized by its narrow, pointed head. And, finally, pale, immature individuals of *Micrura griffini* occur in the same locality, but the presence of lateral cephalic furrows will distinguish this species from the above mentioned.

Carinoma Oudemans.

Quart. Journ. Micr. Sci., **25**, Suppl., pp. 1–80, 1885.

Body usually slender, often thickened and rounded anteriorly, flattened in intestinal region ; head usually wider than parts immediately following ; mouth situated immediately behind the brain ; proboscis pore subterminal. Lateral slits, cephalic grooves, ocelli, and cerebral sense organs wanting, although a row of sensory pits occurs in the median line on the dorsal side of the head in at least three of the four known species. Intestine with paired, lateral diverticula.

Body musculature composed of two muscular layers throughout length of body, and of localized supplementary layers. These consist of a thick internal longitudinal layer and a thin external circular layer, but in the esophageal region a second circular layer lies internal to the longitudinal muscles, and just in front of the nephridial region becomes enormously thickened. In the anterior portions of the esophageal region a double set of distinct diagonal muscles lies just internal to the outer circular muscular layer.

The lateral nerves are situated within the longitudinal muscular layer.

In the anterior portions of the esophageal region are three pairs of longitudinal blood vessels, of which one pair represents the main lateral vessels and lies beside the esophagus, a second pair lies beside the proboscis sheath, and the third pair is situated internal to the ventral wall of the proboscis sheath and projects freely into the rhynchocoel.

But a single species of this uncommon but widely distributed genus is as yet known from the Pacific coast, and only three species have been found in other parts of the world. The latter are *C. armandi* Oudemans, from the coasts of Europe, *C. patagonica* Bürger, from the Straits of Magellan, and *C. tremaphoros* C. B. Thompson, from New England.

9. Carinoma mutabilis Griffin.

Ann. New York Acad. Sci., **11**, p. 204, 1898.

Carinoma griffini Coe, Proc. Wash. Acad. Sci., **3**, p. 20, 1901.
Carinoma mutabilis Coe, Harriman Alaska Expedition, **11**, p. 115, 1904.

Pl. **12**, figs. 76–80; Pl. **13**, figs. 81, 82; Pl. **14**, figs. 83–87; Pl. **15**, figs. 88, 89.

This interesting species can be distinguished from the other nemerteans at present known from the Pacific coast by the above generic diagnosis, and especially by the slender body, rounded anteriorly and much flattened towards posterior extremity, which is remarkably broad and flat; head rounded or emarginate in front, wider than neck; color pure white anteriorly, with cream-colored or brownish intestinal region. The worms often show a tendency to coil the posterior portions of the body in a spiral.

There is very great variation in size, small individuals being scarcely more than 25 mm. in length, while the largest specimen recorded measured more than half a meter when fully extended, with a diameter of but 3 to 5 mm. On the California coast few individuals were collected which were above 20 cm. in length, while the average size was much less.

Griffin ('**98**, p. 204) describes considerable variation in size, form,

habits, and internal anatomy, and indicates these peculiarities by two varietal names. Careful study of his preparations, however, and a comparison with specimens collected in California, show such a close intergradation that it seems certain that all the forms of the genus thus far collected on the Pacific coast belong to a single variable species. The apparent amount of gelatinous tissue, or parenchyma, is largely dependent on the state of contraction of the parts.

After preservation the natural colors are completely lost; the body becomes nearly cylindrical and is flattened only towards its posterior extremity; head is not usually distinctly marked off from body, and in only a few specimens is it broadened as in life.

In internal organization the species agrees closely with the descriptions and figures which Bürger has published for *C. armandi* ('95) and *C. patagonica* ('96). Bergendal has recently (:02, :03, and :04) furnished additional observations on *C. armandi*. In many details, however, the present species presents such interesting anatomical peculiarities that a rather extended description of the internal anatomy seems to be warranted.

Integument and body walls.— 1. The outer integument, with its superficial layer of columnar ciliated cells and deeper layers of gland cells, is much as in *C. armandi*. About the middle zone of this epithelial layer we meet an irregular network of slender fibers, corresponding to the muscular layers described by Bürger ('95). Bergendal (:02, p. 14) has also described these epithelial muscles in detail. In the species at hand, both circular and longitudinal layers are readily distinguished.

2. The basement layer (Pl. 12, fig. 79; Pl. 13, figs. 81, 82) of fine connective tissue fibrils and gelatinous tissue is far more highly developed than in any of the other species of the genus. In the esophageal region it is about equal in thickness to the integument itself, but decreases greatly farther back.

3. Beneath the thick basement layer, and not sharply demarcated from it, is a comparatively loose sheet of circular muscular fibers (Pl. 12, fig. 79). These fibers are more slender and scattered than those of the other muscles of the body, and are intimately connected with the surrounding connective tissue. The layer varies greatly in thickness in different portions of the body, but is never very strong. It extends throughout the length of the body.

4. A sharply marked layer of diagonal muscles (Pl. **12**, fig. 79, *dm*) lies just external to the main longitudinal layer. This oblique layer is made up of two distinct sheets of fibers separated by a thin layer of connective tissue. The parallel fibers of the outer sheet of oblique muscles cross those of the inner sheet at nearly right angles, and are thus most conducive to the strength of the body. The oblique muscles thin out and disappear near the end of the esophageal region.

Besides the definite layers, the integument is penetrated by numerous irregularly arranged fibers similar to those found in Carinella and Carinomella.

5. In most regions of the body the main longitudinal muscular layer presents a thickness greater than that of all the other muscular layers combined (Pl. **12**, fig. 79; Pl. **13**, figs. 81, 82). Throughout the intestinal region the outer circular layer becomes extremely thin, while all the others except the longitudinal layer disappear entirely, so that this latter represents almost the whole of the musculature. Only in a limited portion of the esophageal region do the inner circular muscles rival it in thickness. The lateral nerve cords lie imbedded in this layer (Pl. **13**, figs. 81, 82), which forms the innermost portion of the body walls proper.

6. Internal to the longitudinal muscles lies the gelatinous tissue, or parenchyma, of the body cavity. This layer is but slightly developed in most parts of the body, and in the anterior esophageal region is scarcely represented. Farther back it is more conspicuous, but is never voluminous in this genus.

7. The inner circular muscular layer (Pl. **12**, fig. 79; Pl. **13**, fig. 81) can be followed continuously from the mouth to the anterior end of the intestinal region. Its fibers are continuous with those of the proboscis sheath, and, as stated below, it appears to originate as a further development and prolongation of the proboscis sheath musculature. Anteriorly it is even thinner than the outer circular layer, but toward the posterior end of the esophageal region it increases so greatly in massiveness that for a short distance it exceeds in thickness the other muscular layers combined (Pl. **13**, fig. 82). Having reached its maximum development (near the efferent nephridial ducts) it suddenly disappears entirely, its dorsal portion remaining for a few sections as a semicircular arch above the proboscis sheath.

Where this layer is most massively developed (Pl. 13, fig. 82) the dorsal and ventral median nerves become greatly increased in size, and lie immediately on its periphery above and below. This inner circular layer belongs more properly to the viscera (alimentary canal and proboscis sheath) than to the body walls. It is not composed exclusively of circular muscular fibers, but contains an abundance of longitudinal ones arranged in minute bundles (of a few fibers each) between the circular fibers.

Throughout its length the inner circular layer is connected with the outer both dorsally and ventrally by means of fibrous decussations (Pl. 13, fig. 81).

In the head (Pl. 12, fig. 78) an outer circular muscular layer lies immediately beneath the cephalic glands, while the blood lacunae are mainly surrounded with longitudinal muscles. A few circular fibers surround the rhynchodaeum, but the layers are all more or less interrupted by irregular oblique or dorso-ventral fibers.

A thin band of longitudinal muscles lies between the proboscis sheath and alimentary canal, as described below.

Proboscis sheath.—The proboscis pore is minute and situated subterminally (Pl. 12, fig. 76).

The proboscis sheath is strongly developed. There is a single muscular layer composed of circular fibers interspersed with longitudinal fibers in small groups. The muscular layer is throughout much thicker than in either of the other species of the genus. In the esophageal region this musculature is continuous with the internal circular muscular layer, which becomes so enormously thickened in the nephridial region (near the posterior end of the esophagus). The rhynchocoel is thus bound up in the same musculature as the esophagus (Pl. 13, fig. 81).

Bürger ('95) prefers to consider the muscular layers of the proboscis sheath as wanting in the region where the internal circular muscular layer is developed (in the whole of the esophageal region), and that its walls consist only of a flattened epithelium supported by a thin basement membrane. The musculature of the proboscis sheath, however, is encountered in front of the mouth, and extends without a break as far backward as the anterior end of the intestinal region. In the region of the mouth it is clearly evident that these same muscular fibers which compose the muscular wall of the proboscis sheath extend ventrally and surround the esophagus. At

first there are a few straggling fibers only, but farther back they increase in numbers until they form the enormously thick layer of internal circular muscles. This layer, then, would represent merely a great development and ventral prolongation of the proboscis sheath musculature. The character of the layer is the same as is seen in the proboscis sheath in the intestinal region; that is, circular fibers interlaced with those which run longitudinally.

Between the rhynchocoel and the esophagus is a musculature consisting of a dorsally placed sheet of circular fibers, and a ventral layer of longitudinal muscles. These longitudinal muscles are evidently homologous with the massive muscle-bundle found in the same position in CARINOMELLA (p. 129). These layers are most distinct in the anterior esophageal region, and practically disappear when the internal circular muscles become most massive.

The rhynchocoel is of greatest diameter in the anterior portion of the esophageal region (Pl. **13**, fig. 81), narrows greatly in the nephridial region (Pl. **13**, fig. 82), and widens abruptly again at the point where the internal circular musculature ceases.

Alimentary canal.— Mouth situated behind brain and provided with thick, folded lips, and a highly columnar ciliated epithelium, as in the related species. Esophageal canal is extremely short, and becomes very narrow in region of greatest thickening of inner circular muscle and just before opening into the broad intestinal canal, with its deep lateral diverticula. But even in this short distance the esophagus is divided into two distinct chambers (Pl. **12**, fig. 76), which are clearly distinguished in the living worm. The anterior chamber, or esophagus proper, leads directly from mouth, and is opaque whitish and has a glandular appearance in life. It presents a distinct constriction before opening into the posterior esophageal cavity, or stomach. The two chambers are well marked, both anatomically and histologically, in the mounted sections.

The anterior chamber is lined with highly columnar ciliated and glandular cells, the former having comparatively short cilia, and the latter a rather homogeneous secretion, as described for CARINOMELLA (p. 137), while the stomach has a much thinner epithelium, with fewer and longer cilia and with peculiar granules of secretions in the gland cells, as is also described for CARINOMELLA (p. 138). The epithelium of both chambers is similar to that described by Miss

Thompson (:02) for the similar portions of the alimentary canal of ZYGEUPOLIA.

The posterior portion of the stomach becomes very much constricted because of the great growth of the inner circular muscles of the body walls (Pl. 13, fig. 82), but at the posterior end of these muscles it spreads out suddenly into the broad intestinal canal (Pl. 14, fig. 83). As shown in Pl. 12, fig. 76, there are a few very small intestinal diverticula anterior to those which are fully developed. The gradation between stomach and intestine is thus apparent, and the demarcation is as gradual histologically as anatomically, as in ZYGEUPOLIA. The intestinal diverticula are very deep (Pl. 12, fig. 76; Pl. 14, fig. 87) and are often forked distally, very much as in CEREBRATULUS.

Blood vascular system.— In the portions of the head in front of the brain we find very large blood lacunae, which are much interrupted and divided into communicating chambers by fibrous strands of tissue extending from the dorsal to the ventral sides (Pl. 12, fig. 78). The lacunae of the two sides find abundant channels of communication through lacunae lying both above and below the rhynchodaeum. The anterior ends of some of these lacunae are lined with clusters of deeply staining gland cells, the secretions of which are discharged directly into the blood spaces. They resemble the clusters of glands found in certain portions of the rhynchocoel in various other species.

At the anterior end of the mouth, and immediately behind the attachment of the proboscis to the rhynchodaeum, the lateral blood spaces become divided into a dorsal and a ventral pair of vessels, as in the other species of the genus. The ventral pair constitute the main lateral vessels which extend throughout the length of the body, while the dorsal pair unite with the ventral just back of the nephridial region. The ventral are distinguished from the dorsal not only by position, but also in having much thicker walls — that is to say, the ventral vessels have a strong fibrous sheath, while the dorsal are mere spaces in the parenchyma with extremely few fibers in their walls. It often happens that the ventral appear much smaller than the dorsal vessels, but this is probably because the contractile fibers of the former contract so as to greatly diminish the size of the vessel on the death of the animal, just as the arteries, with their more muscular walls, are smaller than the corresponding veins in the dead body of a vertebrate.

Just back of the brain a pair of branches from the main lateral vessels pass obliquely upward to enter the cavity of the proboscis sheath. These vessels lie on the ventro-lateral borders of the rhynchocoel and project freely into its cavity. Near the middle of the esophageal region they disappear, and probably join the dorsal pair of lateral vessels, as in *C. armandi*. I was unable to demonstrate any distinct communications, however, in the sections at my command.

Nephridia.— The pair of nephridial canals makes its appearance near the posterior end of the esophageal region, and extends a short distance backward into the intestinal region. In the anterior portions of the canals we find small, but complexly branching tubules, which grow out into the ventral walls of the lateral blood vessels, as described for other species of the genus. These tubules are often almost completely surrounded by the blood, and the mass of tubules constitutes the so-called *nephridial gland* (Pl. **14**, figs. 84, 85). This mass of tubules does not extend into the cavity of the blood space nearly so far as in *C. patagonica*, but the tubules are much more profusely branched than in *C. armandi*. The condition in *C. mutabilis* is in many respects intermediate between the two other species, and the general structure is closely similar to that which Bürger ('**95**) describes and figures in *Carinina grata*. The minute tubules of the nephridial gland are lined with flattened epithelium which lies in close contact with the similar epithelium of the blood space. The complex of tubules extends backward just about as far as the position of the external openings of the efferent nephridial ducts — near the posterior end of the esophageal region. Behind this point the nephridial canal changes its character entirely. The tubule increases greatly in size (Pl. **13**, fig. 82; Pl. **14**, figs. 83, 84), separates from the wall of the blood vessel, is no longer branched or convoluted, and its epithelial lining changes from flattened to columnar cells. These cells do not exhibit clearly marked boundaries, but their positions are indicated by the regularly arranged oval nuclei. Each cell commonly shows a very few short cilia. The wide ciliated canal continues backward, with a few irregular twists, into the anterior portion of the intestinal region. Here it bends sharply on itself and passes forward again to the region of the thickened internal circular muscles, where it enlarges still more, and then bends obliquely upward, passes internal to the

lateral nerve cord, and opens to the exterior on the dorso-lateral aspect of the body (Pl. **13**, fig. 82).

As stated above, the efferent ducts lie in the same region as the posterior ends of the nephridial glands. Back of this point a cross section nearly always shows two sections of the nephridial canal just ventral to the lateral blood vessel (Pl. **14**, fig. 83). One of these sections commonly lies nearer the median line than does the blood vessel, and this represents that portion of the canal which is passing posteriorly, while the other lies a little nearer the lateral margin of the body, and corresponds to the limb of the vessel which is passing forward toward the efferent duct. Both limbs lie just internal to the longitudinal muscular layer, but sometimes (Pl. **14**, fig. 83) penetrate this layer, and are connected with the outer portions of the body walls by strong fibrous bands.

The efferent ducts, which are narrower than the longitudinal canals, pass just externally to the dorsal pair of lateral blood vessels, and in penetrating the outer circular muscular layer spread out and lose their characteristic lining of columnar epithelium.

In figure 82, Pl. **13**, and figure 83, Pl. **14**, the large efferent duct on the left side opens directly outward, while the small duct beside it, and nearer the median line, runs far backward and then bends forward to the efferent duct. On the right side the nephridial system is cut a little more posteriorly. The canal lying in contact with the dorsal lateral vessel is the right efferent duct, which in this instance bends obliquely backward. The nephridial canal lying nearest the lateral nerve is the limb which passes forward to the efferent duct, while the one lying nearer the median line is the limb which runs backward. Occasionally a third canal is cut on one side, and this is where a bend occurs in one of the longitudinal canals.

Nervous system.—The nervous system is closely similar to that in *C. armandi*, as described by Bürger ('**95**). The brain is voluminous and both commissures are large.

A pair of large buccal nerves is given off from the internal borders of the ventral ganglia immediately behind the commissures. These nerves lie immediately beneath the epithelium of the mouth and anterior portion of the esophagus, as in other genera.

The large dorsal median nerve extends from the dorsal commissure backward into the intestinal region. Anteriorly it lies external

to the outer circular muscular layer (Pl. **13**, fig. 81), but back toward the nephridial region it breaks through the outer circular, diagonal, and longitudinal muscles, and takes up a position just outside the enormously thickened inner circular muscles. Back in the intestinal region it lies directly upon the proboscis sheath (Pl. **14**, fig. 83).

A ventral median nerve is also present. This nerve likewise lies outside the outer circular muscles in the anterior esophageal region (Pl. **13**, fig. 81), and passes inward to occupy a position between the two circular muscular layers farther back. It is most conspicuous where the inner circular muscles are thickest (Pl. **13**, fig. 82), as figured by Bürger for *C. patagonica.*

The lateral nerves lie close to the diagonal muscles in the anterior esophageal region, but toward the nephridial region pass somewhat internally and lie imbedded in the midst of the longitudinal muscles (Pl. **13**, fig. 82; Pl. **14**, figs. 83, 87).

Cephalic sensory pits. — A number of small sensory pits are situated on the dorsal surface of the head in the median line between the brain and the tip of the snout. Such organs were first discovered in *Carinoma tremaphoros* by Miss C. B. Thompson (:**00**, p. 627), and have since been found by Bergendal (:**03**, p. 610) in *C. armandi.*

Whether future study will reveal their presence in *C. patagonica* Bürger is of course a matter of speculation, but since they are known to occur in three of the four described species of the genus and have been found in no other nemerteans they may be looked upon as probably characteristic of the genus.

In the first specimens of *C. mutabilis* which I examined, these sense organs were very inconspicuous, and were not mentioned in my previous description of the species (:**01**, p. 20). They are actually present, however, in all of my preparations.

Their structure agrees closely with the account given by Bergendal (:**03**, p. 610), but in no case are they sufficiently well preserved to reveal any other details of structure than those mentioned by Miss Thompson and by Bergendal (see p. 62). They agree with Bergendal's description and differ from those described by Miss Thompson in being well separated from the surface of the integument and in being connected with the exterior by a narrow canal only. Bergendal states in a later paper (:**04**) that such apparent differences

are actually due to the states of contraction of the parts. Their number apparently varies from 6 to 10 in different individuals.

Reproductive organs. — Ovaries and spermaries develop between the intestinal lobes and are mature in August, both on the California coast and in Puget Sound.

Habitat. — In sand and in hard blue clay between tides, and on piles of wharf, in Strait of Juan de Fuca and in Puget Sound, (Griffin, '98); between tides, Vancouver Island, collected by Shearer (Coe, :01); common in sand between tides in San Pedro Harbor, California; also found in sand in San Diego Harbor, California, but not in abundance.

Cephalothrix Oersted.

Entwurf der Plattwürmer, Kopenhagen, 1844.

This genus includes very long, slender, filiform species which show a tendency to coil in a close spiral. Brain situated well behind tip of snout; mouth several times as far posteriorly. Head sharply pointed in extension; proboscis pore on ventral side a little back of its extremity. Inner circular muscular layer very much reduced, or (commonly) entirely absent, the body musculature consisting of a thin outer circular muscular layer and a strong inner longitudinal layer; lateral nerves situated in the longitudinal muscular layer; cerebral sense organs and cephalic furrows wanting. These worms resemble in external appearance some of the slender nematodes.

A single species, which is also found in European waters and on the east coast of North America, occurs abundantly on the Pacific coast of Alaska. Three other species of the genus have been described from Europe and a fifth occurs in the Indian Ocean at the Maldive Islands (Punnett, :01b).

10. Cephalothrix linearis (Rathke) Oersted.

Planaria linearis Rathke, Skrivter af Naturhist. Selsk. Kjöbenhavn, **5**, p. 84, 1799.

Cephalothrix linearis Oersted, Entwurf der Plattwürmer, p. 82, Kopenhagen, 1844. Coe, Proc. Wash. Acad. Sci., **3**, p. 19, 1901; Harriman Alaska Expedition, **11**, p. 19, 1904.

This is a very slender thread-like species, capable of great extension and contraction. Individuals may be extended till they resemble a very fine thread, 7 to 15 cm. or more in length, but when disturbed commonly coil themselves into a closely wound spiral. Body usually rather thicker in the middle and tapering toward both extremities. Head very long, acutely pointed when extended. Proboscis-pore situated ventrally. Mouth very far back; commonly distant from tip of snout four to five times as far as is the brain.

Ocelli.— Wanting in adults, although the embryos are provided with a single pair soon after leaving the egg.

Color.— Usually whitish or pale yellow throughout, but some specimens have a distinct reddish tinge, and some are gray, greenish, or pale green.

Habitat.— The species is very common well up toward high-water mark under stones in muddy places, among decaying mussels, etc. The worms were commonly found where the mud was black, slimy, and very foul. Scores of specimens were sometimes found under a single stone. They were often associated with slender reddish nematodes. Very abundant at New Metlakahtla; Glacier Bay; Sitka; Orca, Prince William Sound; and at other places on the Pacific Coast of Alaska (Coe, :**01**). The species is also common on the coast of New England, and is likewise found along the shores of northern Europe and in the Mediterranean.

Taeniosoma Stimpson.

Taeniosoma Stimpson, Proc. Acad. Nat. Sci. Phil., p. 162, 1857.
Polia Delle Chiaje, Mem. sulla storia e notomia degli animali senza vertebre del regno di Napoli, Naples, 1823–28.
Eupolia Hubrecht, Report of Challenger Exped. Zoöl., **19**, 1887.
Eupolia Bürger, Fauna u. Flora von Neapel. Monogr. **22**, p. 598, 1895.
Taeniosoma Coe, Proc. Wash. Acad. Sci., **3**, p. 61, 1901.

For reasons stated elsewhere (Coe, :**01**, p. 4) it seems absolutely necessary to adopt for this genus the name given by Stimpson in 1857 rather than accept that of Hubrecht of 30 years later, even though most European writers have ignored Stimpson's brief, but careful, diagnoses.

The species belonging to this genus show a remarkable specific variation in the general shape and size of the body. Some are characterized by extremely long, slender, flattened, and much twisted bodies, while others are short, thick, and cylindrical. In all the species, however, the snout in life is rounded in front and is sharply marked off from the parts immediately following by lateral constrictions. Horizontal furrows are wanting, but small, oblique or transverse grooves may be present on the head. In strong contraction the esophageal region becomes greatly swollen, the head is drawn in so that the anterior end of the body is large and sharply truncated.

Proboscis sheath and proboscis short, seldom reaching more than one third the length of body. Proboscis opening subterminal, minute. Mouth a small round opening on the ventral surface immediately behind the ganglia.

Muscular layers of body composed of a thick outer longitudinal, a circular, and a less thickened inner longitudinal layer. Outside the muscular layers is a well developed cutis, composed of a thick inner layer of connective tissue and an outer layer of glandular tissue. The external epithelium is thin, as compared with the other layers of the body, though the fibrous layer separating it from the cutis is well developed. The musculature of the proboscis consists of an inner longitudinal and an outer circular muscular layer. Consequently there can be no muscular crosses.

The cephalic glands are enormously developed. They stretch backward on all sides beyond the brain, and even reach some distance into the esophageal region.

The lateral nerves lie immediately outside the circular muscular layer. There are three longitudinal blood vessels.

Ocelli are usually present in great numbers, though very small.

The worms are sluggish in their habits, are unable to swim, and usually show great irregularities in the diameter of the body. They are prone to twist themselves in sharp coils, or in knots, and often lie in lumps. They are usually capable of contracting and extending their bodies to a remarkable degree.

Three species of this widely distributed genus are represented in these collections. One of these forms has been found only on the coast of Alaska and in Puget Sound, the second is known only from the coast of California, while the third has as yet been col-

lected only from the west coast of Central America and the Galapagos Islands.

All these forms are of large size, being among the largest nemerteans of their respective regions.

11. Taeniosoma princeps Coe.

Proc. Wash. Acad. Sci., **3**, p. 62, Pl. 2, figs. 3, 4, 1901. Harriman Alaska Expedition, **11**, p. 62, 1904.

This species can be easily recognized from the large size of the worms (becoming 2 meters long and 20 mm. in diameter) and by their deep ocher yellow color, sometimes with orange or brownish tinge, thickly sprinkled on dorsal surface with minute, dark red spots and blotches, which are often arranged in irregular longitudinal lines. Ventral surface paler, often with greenish tinge, without the reddish spots. When body is strongly contracted anterior portions are greatly swollen and snout is completely withdrawn into posterior portion of head.

Ocelli numerous, commonly 40 or more in an irregular group on each side of snout.

Cephalic glands enormously developed.

Nephridia situated in anterior and middle portions of esophageal region, provided with several small efferent ducts on each side.

Cerebral sense organs voluminous, extending forward on the external and lateral borders of the very large dorsal ganglia nearly as far as the ventral commissure.

Further details of anatomical peculiarities may be found in the papers cited.

Habitat.— A single fragmentary specimen of this gigantic nemertean was found in Griffin's collection from Port Townsend, Wash. The species has been recorded from Cape Fox, Yakutat, and Prince William Sound in Alaska (Coe, :**01**). All were found under stones in hard mud at low water.

The worms contract strongly when handled, throwing the surface of the body into strong, circular wrinkles, and often coil the posterior portion into a close spiral.

Sexually mature late in summer ; the oviducts open dorso-laterally.

12. Taeniosoma mexicana Bürger.

Zool. Jahrb. Abth. Syst., 7, p. 236, Pl. 8, fig. 6; Pl. 9, figs. 2, 3, 1893.

This species occurs very abundantly on the west coasts of Panama and Mexico, and at the Galapagos Islands, but has not been found elsewhere. It belongs to that group of the genus having slender bodies which do not contract to any excessive amount when disturbed or killed. The worms reach a very considerable size, those one or two meters long and 5–7 mm. wide being common. Specimens in collections often measure at least half a meter in length. In shape the body is slender, flattened when strongly contracted, largest just back of head; intestinal region broad and flat; posterior extremity very slender. Snout of moderate size, distinctly marked off from posterior portion of head by conspicuous lateral transverse grooves which form an annular constriction when contracted. Ocelli numerous, situated in an elongated cluster on each lateral border of snout.

Color dark brown, with very numerous fine white rings encircling the body at irregular intervals throughout its whole length. Some of the rings are very much finer than others, and many are more or less broken and incomplete. A large specimen has several hundred of these rings, which remain sharp and conspicuous after the worms have been kept in alcohol for many years. Snout bordered laterally and anteriorly by narrow horizontal white band, which passes through or immediately above terminal proboscis pore and joins the first white ring, which occurs at junction of snout to posterior portion of head. White rings commonly 1 mm. or less in breadth, while alternating brown bands are about 3 mm. wide in moderate extension, but are considerably narrower than diameter of body.

Habitat. — The species has previously been reported from the west coasts of Panama and Mexico, and from the Galapagos Islands (Bürger, '93). A number of large specimens were collected by Mr. Alexander Agassiz and by the Hassler expedition on the west coast of Panama. Several large specimens in the Yale Museum were collected in the same region by Mr. Bradley and another lot by Mr. McNeil. It is apparently the largest and most abundant nemertean found in that region.

13. Taeniosoma punnetti Coe.

Harriman Alaska Expedition, **11**, p. 173, Pl. 16, figs. 1–3; Pl. 18, fig. 6, 1904.

Text-fig. 31.

This species is rather common along the coast of California at a depth of a number of fathoms, but is seldom found between tides. In internal anatomy it presents few characters deviating from those of related forms. The most characteristic features of external appearance and internal structure are as follows: —

Body large, soft, flabby, very contractile, rounded in esophageal region, and much flattened posteriorly when well extended; very short and subcylindrical when strongly contracted; head and anterior portions of body extremely contractile; smooth and somewhat flattened when moderately extended, but abruptly truncated, cylindrical, and thrown into deep circular wrinkles when contracted, the snout being withdrawn into the swollen succeeding portions of head. Mouth variable in size according to state of contraction of anterior portions of body; large and elongated when head is well extended but small and rounded when head is strongly contracted.

Esophageal region often greatly swollen, esophagus apparently serving to some extent as a respiratory organ, as has often been considered the case in Cerebratulus.

Color.— General color of body usually brownish red, mahogany, or dark red, with only a tinge of brown, often appearing as if covered with a delicate whitish bloom. Anterior portion of head much deeper brown or almost black, on dorsal surface sharply marked off from a narrow white border which occupies the terminal and lateral margins of snout (Text-fig. 31).

Ventral side of snout white; this color is continuous with that of margins of dorsal surface, occasionally extending back on ventral side of head proper, and sometimes including mouth region also. Ventral surface of esophageal region of a reddish brown color, similar to that of dorsal surface, but of a paler and more grayish shade, often with grayish median band. Intestinal region of similar color but much influenced by grayish of intestinal canal, often pale gray in median line.

Size.— A large species, individuals often measuring 40–60 cm. in length and 8–10 mm. wide when extended. A preserved specimen still measures 20 cm. long, and 5–7 mm. in width in intestinal region, and 12 mm. just behind mouth. When strongly contracted the body of a large individual may be reduced to 6–8 cm. in length, being several times as thick as when extended.

Ocelli minute but very numerous; situated as an irregular cluster of forty to sixty or more small pigment spots on each side just ventral to the dark head shield (Text-fig. 31).

Proboscis sheath remarkably long, extending backward throughout greater portion of intestinal region. Proboscis large, the two muscular layers well developed.

Cephalic glands enormously developed, extending back a short distance behind the mouth.

Nephridia remarkably extensive, originating a short distance posterior to mouth and extending nearly the whole length of esophageal region. Efferent ducts numerous, 8–12 on each side, but of small size, scattered at irregular intervals along the whole length of the nephridia, and, as usual, passing to the exterior immediately above the lateral nerves.

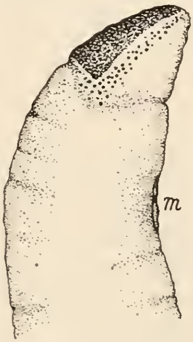

FIG. 31.— *Taeniosoma punnetti.* Outline of anterior portion of body, showing position of cephalic markings and ocelli; *m*, mouth.

Cerebral sense organs highly specialized, rather large, much elongated, situated laterally in the angle between dorsal and ventral ganglia. Near posterior end of dorsal ganglion, the sense organ enlarges until it is nearly as large as the ganglion, with which it fuses completely at its posterior border.

Habitat.— Common among red algae, of color closely approximating that of the worms, in about 50 fms. between San Pedro and Santa Catalina Island, California. Common also in upward of 20 fms. in Monterey Bay, California. Often caught on hooks by the Chinese fishermen in that locality. Sexually mature in August.

Dredged by the Albatross off southern California (Sta. 2975, Lat. 34° 01′ N., Long. 119° 29′ W.) in 36 fms., gravel and broken shells; temperature 57° F. These specimens after remaining 13 years in alcohol still retain indications of their characteristic coloring in life.

The transverse black spot on dorsal surface of tip of snout is perfectly distinct, the dorsal surface of body is pale brownish, while the ventral surface has lost all trace of original coloration.

The worms are very hardy and tenacious of life, being able to live for a day or more among damp seaweeds. They may be kept for a long time in captivity, and do not break up when roughly handled. They are easily preserved without rupture, or without excessive contraction if killed slowly. Natural colors are well retained in formalin.

Zygeupolia C. B. Thompson.

Zool. Anz., **23**, p. 151, 1900.

Body moderately slender; head very long and acutely pointed, without lateral furrows; cerebral sense organs well developed, connected with exterior by ciliated duct opening into shallow pit on lateral margin of head; ocelli wanting; caudal cirrus conspicuous, with large central blood space connected both with lateral and with dorso-median vessels. Proboscis sheath extends throughout length of body; proboscis with but two muscular layers — outer longitudinal and inner circular; proboscis without retractor muscle.

As stated by Miss Thompson (:**02**, p. 731) this genus undoubtedly belongs to the family *Lineidae.* The absence of lateral cephalic furrows is not of very fundamental importance, for, as stated on p. 57, different species of the same genus sometimes show nearly all gradations between deep horizontal furrows and merely slight lateral grooves or pits into which the canals from the cerebral sense organs open. *Cerebratulus coloratus* Bürger is an example of such a form in which lateral horizontal furrows are practically wanting, while other members of this same genus have the most highly developed furrows of any nemerteans.

14. Zygeupolia littoralis C. B. Thompson.

Zool. Anz., **23**, p. 151–158, 1900; Proc. Acad. Nat. Sci. Phil., 1901, p. 657–739, Pl. 40–44, 1902.

Text-figs. 4, 18.

This very interesting species which has been so carefully studied

and fully described by Miss Thompson (:02) may be recognized by the following characters: —

Body rather slender, usually 5–8 cm. in length, rather translucent. Head slender, when extended tapering to a fine point; without cephalic furrows (Text-fig. 18), pure white in color. Esophageal region rounded; white, very pale yellowish or flesh color. Intestinal region flattened in life, but rounded after preservation; color varies from rose to pale yellow, light brown or chocolate brown, being largely dependent on the amount and character of the contents of alimentary canal. Posterior extremity provided with a conspicuous, although slender, white caudal cirrus (Text-fig. 4).

In internal organization, the presence of an internal circular muscle at the beginning of intestinal region, the division of the anterior portion of alimentary canal into esophagus proper and stomach, the opening of the ciliated canals leading to cerebral sense organs into shallow lateral pits on margins of head in place of cephalic furrows, the absence of any retractor muscle of proboscis, and the absence of the inner longitudinal muscle of proboscis are among the more important peculiarities of the species.

Habitat.— Common on the sand flats laid bare by the lowest tides in San Pedro Harbor, California. The species is here associated with several other forms to which it shows a general superficial resemblance. These are *Carinella pellucida*, *Carinomella lactea*, *Carinoma mutabilis*, and immature individuals of *Micrura griffini*. The sharply pointed white head, without lateral furrows, and the conspicuous white caudal cirrus, however, will serve to distinguish ZYGEUPOLIA from any of these other forms.

Lineus Sowerby.

The British Miscellany, London, p. 15, 1806.

Representatives of this genus are characterized by slender, sometimes thread-like bodies, usually rounded throughout. The body is commonly twisted and coiled into an irregular mass. The movements are sluggish. The animals creep over objects and readily move about on the surface of the water, but they are unable to swim. The body is extremely contractile; the head is often slightly wider than the body, of oval shape, and is usually

provided with numerous minute ocelli, often arranged in a single row on each side of the head. A caudal papilla or cirrus, a diagonal muscular layer, and neurochord cells are all wanting. The proboscis sheath is often short in comparison with the length of the body.

This genus is represented in the region covered by this report by at least seven species, of which but one (*L. viridis*) has been found in other parts of the world.

15. Lineus viridis (Fabr.) Johnston.

Planaria viridis Fabricius, in O. F. Müller, Zool. Dan. Prod., 1776; Fauna Groenlandica, p. 324, 1780.

Planaria gesserensis Müller, Zool. Danica, **2**, p. 32, 1788.

Nemertes obscura Desor, Boston Journ. Nat. Hist., **6**, pp. 1 to 12, 1848.

Lineus viridis Johnston, Catalogue British Non-parasitical Worms, pp. 27, 296, London, 1865.

Lineus viridis Coe, Proc. Washington Acad. Sci., **3**, p. 65, 1901; Harriman Alaska Expedition, **11**, p. 65, 1904.

Body moderately slender, rounded throughout, but slightly flattened posteriorly; head slightly wider than the parts immediately following; cephalic slits long and deep, with pale margins above and below, reaching anteriorly close to the proboscis pore. The anterior end of the mouth does not reach quite so far forward as the posterior end of the cephalic slits. Length usually 100 to 200 mm.

On each side of the head in front of the brain and close to the lateral borders is a single row of minute ocelli. The number of these is commonly from four to six on each side, though some individuals have as many as eight, and very young specimens but a single pair.

Color. — The Alaska specimens were dusky or brownish green, becoming dark brown anteriorly, and commonly paler on the ventral surface, especially posteriorly. The species is extremely variable in color, and in other parts of the world green, olive colored, brown, red, and smoky black varieties have been described. The head is very pale on lateral margins and in front. The brain is large, reddish, and shows distinctly through the pigment of the

body. Cerebral sense organs paler but easily distinguished in life, with conspicuous canals leading to the posterior ends of the cephalic slits.

Habitat.— Under stones at low water New Metlakahtla, Annette Island, Alaska (Coe, :01, p. 65). This species, besides being found in Alaska, is widely distributed in northern waters. On the east coast of America it occurs from Long Island Sound to Greenland, and is found on nearly all the coasts of northern Europe. It has also been recorded from the Mediterranean, though it is there comparatively rare. It is usually found under stones in muddy situations between tides.

16. Lineus torquatus Coe.

Proc. Wash. Acad. Sci., 3, p. 66, Pl. 5, figs. 8, 9, 1901; Harriman Alaska Expedition, 11, p. 66, 1904.

Pl. 3, fig. 28.

The following brief diagnosis will serve to distinguish this species, of which a detailed anatomical description appears in the paper cited above:— Body rather stout for genus; head short, pointed in front, slightly demarcated from body; cephalic furrows rather short; ocelli absent; length commonly 10 to 20 or, rarely, 40 cm. in extension, width 3 to 5 mm.

Color.— Usually dark reddish brown, chocolate or purple above, sometimes flecked with minute, inconspicuous whitish specks; paler and commonly more reddish beneath (Pl. 3, fig. 28); a narrow transverse band of white passes across dorsal surface at posterior ends of cephalic furrows; a white spot is situated on tip of snout and is usually, though not always, connected with transverse white band by white borders to cephalic furrows. Color of body is retained for many years in alcohol.

Internal anatomy.— Proboscis slender, of medium size, colorless, internal longitudinal muscles practically wanting; cephalic glands well developed; esophageal nerves remarkably large, connected at intervals with the lateral nerve cords; dorso-median nerve correspondingly highly developed; nephridial canals extend through anterior half of esophageal region, of remarkably large size, sometimes equal to lateral nerve cords in diameter, with a single pair of

very large efferent ducts situated at about two thirds the distance toward their posterior ends. For further details of anatomical peculiarities, see Coe, :01 or :04.

Habitat.— Common in mud and under stones in muddy localities in Prince William Sound, Alaska (Coe, :01). Also collected by Dr. W. H. Dall under stones, Unga Island, Alaska. These latter specimens, although collected 30 years ago, still retain a deep purple color, and the white spot on tip of snout can still be distinguished.

The individuals are hardy and of sluggish movements. They do not break up nor contract excessively when thrown into killing fluid, and the proboscis is not usually everted when the animal is killed. Some, especially the smaller ones, when preserved are nearly cylindrical, but most individuals are flattened ventrally.

17. Lineus rubescens Coe.

Harriman Alaska Expedition, **11**, p. 179, Pl. 14, fig. 1; Pl. 15, figs. 3, 4; Pl. 22, fig. 1, 1904.

Pl. 3, fig. 33.

This beautifully colored but rather uncommon Californian species may be easily recognized by the following peculiarities:—

Body very slender, rounded anteriorly, flattened in intestinal region; posterior extremity slender; head long, rather broad; cephalic furrows correspondingly long, reaching posteriorly as far as anterior end of mouth, which is situated well back from tip of snout.

Size.— A small species, individuals seldom exceeding 10–15 mm. in length and 1 mm. in diameter.

Color.— Anterior portions of body, except tip of head, pink or rosy flesh color; sometimes bright pinkish red, and often with bluish tinge. Anterior end of head, both above and below, white, sharply marked off from pink color behind (Pl. 3, fig. 33). Intestinal region varies from deep flesh color to pale purplish brown anteriorly, shading off to very pale pinkish toward posterior end of body. Ventral surface paler, but of similar color, often with still paler median line. Intestinal lobes flesh color, buff, or occasionally, brownish or purplish. Head can be so much contracted that white tip will disappear.

A most striking peculiarity of the color in esophageal region is that it becomes purplish or bluish after preservation in formalin. The bluish color is not permanent, however, but disappears in a few weeks. But when such specimens are cleared in cedar oil, a delicate bluish or bluish green color reappears in esophageal region, while intestinal region remains colorless or slightly brownish.

Ocelli.— Two to four, or rarely as many as six to eight, ocelli on each side, irregular in shape, very dark reddish or almost black in color, are closely placed in a single row in whitish area on tip of head. Anterior ocellus on each side usually the largest, but the ocelli are often irregularly joined together, appearing rather as a row of scattered pigment masses on each side. In microscopic sections the eyes appear deep blue in color.

Cephalic glands extensive, reaching inward almost to the blood lacunae in anterior portions of head; not extending behind brain except on ventral side, where they reach as far as posterior ends of cerebral sense organs.

Cutis glands remarkably well developed. Back of mouth they sink gradually through the cutis and deeper into the external longitudinal muscular layer. Farther back the glands reach inward to the circular muscle except in the vicinity of the lateral nerves. Throughout intestinal region they border the whole surface of the circular muscles, except near the lateral nerves.

Proboscis.— Proboscis sheath remarkably long for genus, extending nearly to posterior extremity of body. Circular and outer longitudinal musculature of proboscis of the usual proportions; inner longitudinal muscles represented only by two bands placed symmetrically on opposite sides of proboscis. These two longitudinal bands are of considerable thickness anteriorly, but gradually disappear farther back, allowing the internal epithelium to border the circular muscles without interruption except from the nervous layer. Proboscis nerves well developed anteriorly, spreading out into a plexus farther back.

Esophagus presents well marked division into esophagus proper and stomach. The former is lined with highly columnar, ciliated epithelium and provided with an abundance of glands. The ciliated cells are situated superficially and their nuclei are not far removed from the surface, while the glandular cells lie mainly at a lower level and have their nuclei farther from the surface. The

stomach has comparatively few ciliated cells and the nuclei of all are far removed from the surface. The cells are all very slender, and are thickly packed with small granules of secretions. The free surfaces of the cells are irregular and covered with the secretion which partially fills the lumen of the esophagus, so that it is often difficult to determine exactly where the cells terminate. The ciliated cells of the esophagus proper, on the other hand, always show distinct free borders.

Stomach is fully four times as long as esophagus, and at its posterior extremity enters the broad cavity of the intestine, which is provided with the usual lateral diverticula and exhibits the usual histological features. The transition from stomach to intestine is very abrupt both anatomically and histologically.

Blood vessels nearly as in related species. Rhynchocoel vessel very short, leaving cavity of proboscis sheath in the immediate vicinity of the nephridial pores.

Nephridia remarkably short, but with rather large branches; extending from near the mouth through anterior fifth of esophageal region only. The two longitudinal canals swell out posteriorly into comparatively large chambers, from which the single pair of efferent ducts pass to the dorso-lateral surfaces of the body.

Cerebral sense organs well developed, closely united with posterior surfaces of dorsal ganglia.

Habitat.— A few specimens of this beautifully colored species were found on piles at San Pedro, California. The species occurs also at Monterey, California, but is not common.

18. **Lineus flavescens** Coe.

Harriman Alaska Expedition, **11**, p. 184, Pl. 17, figs. 3, 4, 1904.

Pl. **3**, fig. 30.

Body of moderate proportions; head long and rather slender, usually a little narrower than body, often pointed, and often slightly emarginate in front; cephalic slits longer than in most related species; esophageal region rounded; intestinal region only moderately flattened; posterior extremity rather slender, without caudal cirrus.

Color.— General color of body yellowish, of a great variety of shades in different portions of the body and in different individuals. Commonly pale yellow, sometimes with a tinge of orange anteriorly, and deep ocher throughout remainder of body. Margins of head paler. Some are deep ocher anteriorly, with a sharp, median, dorsal, longitudinal white line extending through anterior half of esophageal region, while remaining portion of esophageal region is greenish ocher, and intestinal region dull orange. Ventrally the color is dull whitish on head and in anterior esophageal region, then greenish ocher back as far as intestinal region which is of same orange color as dorsal surface, but somewhat duller. Smaller specimens are commonly much paler in color. Other individuals are of duller colors with dark buff intestinal regions. Still others are golden brown anteriorly (Pl. 3, fig. 30), with a tinge of yellowish orange on the head; intestinal region ocher, buff, or olive brown, sometimes showing a median dorsal longitudinal stripe of darker, more brownish color when filled with mature sexual products. Brain region indicated by its more rosy color; lateral and anterior margins of head very pale or colorless (Pl. 3, fig. 30).

Size.— Small, pale-colored individuals 8–15 mm. long; others 20–40 mm., while those from deeper water are often 80–120 mm. in length, with a diameter of 2–3 mm.

Ocelli.— On each side of tip of head is a transverse row of irregular pigment masses indefinite in shape, size, and number, and varying in color from blood-red to purple or black. Commonly three to seven irregular groups of pigment granules on each side. Most anterior ocellus commonly is much larger than any of the others, while the three or four posterior ones are represented by minute dots only. Ocelli often fragmented, and scattered as irregularly clustered pigment granules. Color of ocelli usually purple or reddish in individuals dredged from among red seaweeds.

Proboscis. — Proboscis sheath extends nearly to end of body. Proboscis pale yellow; attached to dorsal wall of sheath at the posterior end of esophageal region by a powerful retractor muscle. In this same region circular muscles of proboscis sheath extend ventrally to surround the esophagus with a rather thick layer of circular muscles, forming an inner circular muscular layer of the body walls, as in *Micrura alaskensis* and *Zygeupolia littoralis*; this

is apparently homologous with the inner circular muscular layer of CARINELLA, CARINOMA and other Paleonemerteans. Muscular walls of the proboscis consist of outer longitudinal and inner circular layers only; inner longitudinal layer completely wanting. The two proboscis nerves conspicuous in anterior portions, but farther back spread out into a plexus as usual. Basement layer of the proboscis epithelium is therefore separated from the circular muscular layer only by the nerves or nervous plexus, as described for *L. rubescens*.

Cephalic glands are well developed, but extend backward only to the anterior portion of the brain region.

Cutis glands form a thick and distinct layer in the midst of the outer longitudinal muscles. Anteriorly they lie well toward the periphery of this muscular layer, but sink gradually deeper until in the nephridial region they lie in contact with the circular muscles dorsally and ventrally. This condition is retained throughout intestinal region.

Alimentary canal.— Mouth large, elongated, situated opposite posterior ends of cephalic slits. Esophagus divided into two distinct regions. These consist of an anterior, pear-shaped cavity, or esophagus proper, and a posterior chamber, or stomach, connecting with the intestine. Circular muscles about the posterior end of stomach form a strong sphincter between this chamber and the intestine.

Nephridial canals of large size, but of limited extent; situated beside the posterior fourth of esophagus proper, and anterior third of stomach, with one or two pairs of large efferent ducts.

Habitat.— In crevices of rocks and among annelid tubes between tides, San Pedro Harbor, California; common among red algae in 50 fms. between San Pedro and Santa Catalina Island.

The worms belonging to this species are remarkably hardy and will live for more than a day in damp seaweed at a temperature of 70–80° F., and may be kept for a long time in confinement in a small quantity of sea-water. Sexual products mature in July or August.

19. Lineus pictifrons Coe.

Harriman Alaska Expedition, **11**, p. 188, Pl. 17, figs. 5, 6, 1904.

Pl. 3, fig. 36.

This species may be recognized by its dark color and peculiar markings on head and body, and by the following characteristics of external appearance and internal anatomy.

Body remarkably soft and flabby, very changeable in shape, but usually somewhat flattened throughout; often snarled, twisted, and tied in knots; fluted longitudinally, and constricted transversely when contracted. Head narrower than body, elongated, often emarginate in front, narrower at posterior end of unusually long cephalic slits than in its middle portion; ocelli wanting.

Size.— Commonly 5–15 cm. long, and 3–4 mm. in width, occasionally attaining a length of half a meter.

Color.— General color of body, both above and below, deep brown, chestnut or slaty, with a tinge of green in reflected light, or of plumbago or bluish when seen in shadow; sometimes with reddish tinge, and usually with a soft, velvety sheen. Head with a rosy or chestnut tinge beneath the brown. Posterior extremity very pale in color. Body usually shows a series of transverse and longitudinal yellowish markings on dorsal surface (Pl. 3, fig. 36). Transverse markings are the more conspicuous and consist of a series of 40–100 or more lemon yellow rings, the more anterior of which commonly encircle the whole body, while those farther back appear on dorsal surface only. They usually have diamond-shaped thickenings in median line. Markings are much obscured in some specimens and occasionally are almost completely wanting. Most anterior marking is situated at posterior end of cephalic furrows; it is usually much larger and more conspicuous than any of the others, although limited to dorsal surface.

Dorsal surface corrugated with longitudinal flutings, often accentuated by very fine hair-like longitudinal lines of ocher or orange color which extend throughout most of the body. Lines not only very fine and inconspicuous but much interrupted and irregular, usually wavy, and often consisting of rows of elongated dots of color; much interrupted on head, appearing only as rows of very

minute dots. Commonly seven to fifteen of the fine lines, of which the one in the median line is the most distinct and connects the transverse, diamond-shaped yellow markings (Pl. 3, fig. 36).

Peculiar coloring on tip of head especially characteristic, consisting of a narrow terminal border of white enclosing two oval, orange colored spots imbedded in an area of lemon yellow. Sometimes with a few dark brown dots in the yellow color.

Body black or slaty after preservation, often without indications of the characteristic markings seen in life.

Proboscis very long and slender; salmon or flesh colored; provided with two muscular layers only, the internal longitudinal muscles being wanting.

Pigment of body situated in a very dense layer of minute granules immediately beneath the epithelium.

Cutis glands massed in a distinct layer just beneath the pigment layer, not extending among the fibers of outer longitudinal muscles.

Cephalic glands voluminous, extending back both dorsally and ventrally nearly to the brain.

Alimentary canal.— Esophagus remarkably short in comparison with length of body, constricted at posterior end to form a sphincter which opens into a widened posterior chamber or stomach of even less extent than esophagus proper. Change from esophagus to stomach very abrupt both anatomically and histologically, yet it is quite impossible to determine exactly where the stomach ends and the intestine proper begins, the cells of the axial cavity of the intestine retaining the appearance of the stomach cells for some distance posteriorly.

Blood system.— In region of stomach there are five large blood vessels in a transverse section of the body — the rhynchocoel vessel, the pair of lateral lacunae situated in the angle between stomach and proboscis sheath, and the pair of ventral vessels situated latero-ventrally beneath stomach. At the beginning of intestinal region the lateral lacunae pass ventrally to join the ventral vessels, which continue to posterior end of body. Rhynchocoel vessel passes beneath proboscis sheath at beginning of intestinal region.

Nephridia very limited in extent, being found only in the middle half of the very short esophageal region; with a single pair of efferent ducts opening dorso-laterally.

Peripheral nerves remarkably conspicuous, the cephalic and

esophageal nerves being unusually large. Both dorso-median and internal dorso-median nerve clearly marked and of remarkably large size.

Cerebral sense organs voluminous, bathed posteriorly in the large lateral blood lacunae as usual. Cephalic slits of moderate depth.

Habitat.— Rather common in crevices of rocks and under stones between tides, as well as in mud among tunicates growing on piles of wharves, San Pedro, California. Dredged in several localities off San Pedro in 2–20 fms.

A single specimen was collected by the Albatross at Santa Margarita Island, Lower California. This specimen has remained bluish black after standing many years in alcohol, but the transverse markings have disappeared, although there are indications of the exceedingly fine longitudinal lines on dorsal surface. Tip of snout whitish, as is usual in preserved specimens.

20. Lineus wilsoni Coe.

Harriman Alaska Expedition, **11**, p. 195, Pl. 16, figs. 10, 11, 1904.

Pl. **3**, fig. 37.

This species occurs abundantly at several localities on the coast of California and may be recognized by the following peculiarities:—

Body only moderately slender, rounded anteriorly, flattened in intestinal region, but with rounded lateral margins; head very long, slender, somewhat narrower just back of brain but not distinctly marked off from body; cephalic furrows remarkably long; mouth large, situated far behind tip of snout and immediately behind brain; proboscis pore subterminal, near ventral margin of terminal white border; proboscis slender, color very pale, with a tinge of yellow; proboscis sheath extends very nearly to the posterior extremity of the body; intestinal region commonly much wrinkled and with numerous constrictions; posterior extremity not very slender.

Ocelli wanting.

Body fragile, often constricted at the white rings described below, and it is through these rings that spontaneous fission usually takes place. Position of first rupture is usually through third white ring, while the rings in front and behind remain intact.

Color.— General color of body deep chestnut brown, reddish brown, slaty brown, purplish brown, brownish black, or occasionally dark drab, the shade varying considerably in different parts of the body, and usually having more or less of a grayish tinge (Pl. **3**, fig. 37). Sometimes chocolate brown in esophageal region, and much paler brown with shades of reddish or buff posteriorly.

Color of under side of body much like that of dorsal surface, but usually paler and more grayish (Pl. **3**, fig. 37). Ripe ova impart a decided shade of buff to intestinal region. In the darker individuals ventral is nearly as dark as dorsal surface, but the paler individuals are light drab or grayish beneath.

Head bordered anteriorly by a narrow terminal band of white, which extends back along the borders of cephalic slits, sometimes to their posterior ends both above and below, so that when the slits are open they appear white in color (Pl. **3**, fig. 37). White terminal border narrower on ventral than on dorsal surface and less conspicuous owing to paler color of the ventral surface. Head often paler brown in front of brain, deeper brown anteriorly next the white terminal border, and brighter red in brain region from the rosy coloring of this organ.

Body encircled at irregular intervals throughout most of its length by a series of very fine white rings (Pl. **3**, fig. 37). These rings occasionally show slight thickenings in the dorsal median line and often lie in slight annular grooves or constrictions. First ring situated about as far behind brain as is brain from tip of snout. Succeeding rings commonly separated from each other by about the diameter of the body in ordinary states of contraction.

Anteriorly the rings encircle whole body, but farther back are represented on ventral surface by very fine grayish lines only. Rings sometimes very indistinct, and sometimes merely indicated on dorsal surface and entirely wanting ventrally and in posterior portions of body. Rings often disappear after preservation, the body assuming a slaty black appearance, sometimes more grayish below, and with the distinct terminal white border.

Size.— Length commonly 7–15 cm.; width 2–4 mm.

Cephalic glands but little developed. Cutis glands limited to a rather thin, but dense, layer external to the outer longitudinal muscles, not sinking in among the muscular fibers to any great extent even in intestinal region. Pigment of body resides in the connective tissue among the cutis glands.

Nephridial and blood systems.— Nephridia well developed, extending through more than half the esophageal region, reaching anteriorly well toward the mouth, and sending large branches among the esophageal lacunae. Usually with a single pair of large efferent ducts situated somewhat anterior to middle of nephridial region and a little in front of middle of esophageal region.

Nervous system and sense organs show few deviations from those of related species. Esophageal nerves unite in broad commissure just in front of mouth. Cephalic furrows are very deep and long. Frontal sense organs well developed ; situated in three well-marked pits near proboscis pore.

Habitat.— Common at Monterey, California, among kelp 'hold-fasts' attached to stones on sandy or rocky bottom in 2 fms.; Pacific Grove, California, in crevices of rocks and under stones at low water. Dredged in several localities off San Pedro, California, in 2–20 fms.

Collected by Mr. A. Agassiz at Mendocino and at Crescent City, California, in 1860.

21. **Lineus albolineatus** Coe.

Harriman Alaska Expedition, **11**, p. 193, Pl. 17, fig. 2, 1904.

Pl. **2**, fig. 27.

This species somewhat resembles the variety of *Lineus bilineatus* figured by Bürger ('**95**, Pl. 5, fig. 15) in regard to the markings on the anterior portions of the body, although it shows many anatomical differences, as noted below: —

Body of moderate proportions for genus, rounded in esophageal region, flattened posteriorly; head short, broad, commonly a little wider than neck, often slightly emarginate in front, moderately flattened. Cephalic furrows deep, of moderate length, and, in most states of contraction of head, well separated anteriorly; when strongly contracted, however, reaching nearly to proboscis pore.

Color.— General color of body, both above and below, deep chocolate brown or olive brown, with a very conspicuous, sharply marked, white or very pale yellow median dorsal stripe extending whole length of body, and gradually enlarging on head to form a broad, pear-shaped whitish marking, often two thirds to three fourths as wide as head (Pl. **2**, fig. 27). Marking is broadest, and often slightly emarginate, near tip of snout, gradually becoming narrower

through about half the length of the head, where it merges into the narrow dorsal stripe which continues throughout the body. Most individuals show a faint reddish line extending from each cephalic furrow backward along lateral margin of body (Pl. 2, fig. 27). Cephalic furrows often slightly paler, and rosy; intestinal region inclining toward an olive brown shade. Colors and markings of body well retained after preservation.

Size.— Length commonly about 10–20 cm.; width 2 mm. or more.

Ocelli apparently wanting.

Proboscis with only two muscular layers, inner longitudinal muscles being almost completely wanting; consequently the pair of nerves appears to lie directly beneath the inner epithelial layer. Proboscis attached posteriorly by a broad and powerful muscle to dorsal wall of proboscis sheath at the boundary of esophageal and intestinal regions. Back of this point cavity of sheath becomes very small, and extends but a short distance into intestinal region.

Blood lacuna in front of brain very extensive, completely surrounding the walls of rhynchodaeum, except ventrally.

Nephridial system very short, limited to the second fifth of esophageal region; likewise remarkable for the small number and comparatively large size of its branches. A single main nephridial canal on each side, situated in the connective tissue just above lateral blood lacuna, extends backward without branches for a distance fully equal to that occupied by its anterior branching portion; the efferent duct then passes directly outward from the posterior end of the longitudinal canal and opens externally immediately above lateral margin.

Cephalic glands remarkably voluminous, reaching deep into tissues of head, and extending posteriorly almost to anterior end of brain region.

Cutis glands extend inward entirely through the outer longitudinal muscular layer, except toward the lateral margins of body. Pigment of body situated mainly just outside circular muscles.

Habitat.— Dredged in 30 fms., off San Pedro, California, the worms inhabiting strong, parchment-like tubes among broken shells. Found also in 20 fms. in Monterey Bay, California (J. F. Abbott). Not common.

Euborlasia Vaillant.

Buffon's Hist. Nat. des Annelés, **3**, Paris, 1890.

Body usually of large size, remarkably thick and massive, usually nearly cylindrical when fully extended, but very broad and much flattened in intestinal region when strongly contracted. Head continuous with body, but esophageal region often sharply demarcated from intestinal region when contracted. Body is not coiled in a spiral, and worms do not swim, but crawl about with a snail-like motion by extending and contracting the body to an enormous extent. When contracted, intestinal region is often much flattened, with thick lateral margins; it is convex above and concave beneath, and exhibits transverse constrictions at intervals.

Ocelli wanting; proboscis sheath usually much shorter than body; caudal cirrus absent; muscular layers of body possess a bright reddish tinge in life.

But two species of this restricted genus have as yet been described; one of these occurs on the coasts of England and in the Mediterranean, while the other has been recorded from the latter locality only. A third species is represented in these collections by a single specimen from Lower California, and this specimen exceeds in bulk any nemertean as yet described.

22. **Euborlasia maxima**, sp. nov.

Pl. **4**, fig. 40.

This gigantic form possesses a body having a diameter far exceeding that of any described species of nemertean. After preservation for 13 years in alcohol, the body in the intestinal region still measures nearly 45 mm. in diameter and is about 10 mm. in thickness. Length of body of the single preserved specimen, which is strongly contracted but perfectly complete, 29 cm. General shape of body (Pl. **4**, fig. 40), much as in *E. elizabethae.*

Esophageal region cylindrical after preservation, measuring in this specimen 15 mm. in average diameter, considerably thicker and broader near the head than toward the intestinal region. Intestinal region strongly flattened, but with rounded edges, widest in its

middle portions, narrower near esophageal region, and narrowing gradually towards posterior end, which is, however, remarkably thick and rather sharply truncated. Anal opening terminal, conspicuous, colorless. Intestinal region ringed with numerous deep constrictions. A rather conspicuous, but not sharply demarcated, rounded ridge extends in the median dorsal line along the whole length of intestinal region (Pl. 4, fig. 40).

When contracted, as is the single specimen at hand, the intestinal region is much flattened dorso-ventrally, the ventral surface becoming strongly concave and the dorsal surface decidedly convex.

Head comparatively small (Pl. 4, fig. 40), short, broad, pointed in front, not marked off from body; proboscis pore terminal. In the single specimen at hand the anterior portion of head, or snout, is sharply marked off from the posterior portion by an annular constriction, which is probably wanting in life. Cephalic furrows remarkably short and inconspicuous as compared with the great size of the worm, measuring but 3 mm. in length, and extending posteriorly but little farther than the annular constriction which occurs in this specimen behind the snout; they are incompletely separated from the proboscis pore anteriorly. There is also a rather conspicuous vertical groove on the tip of the snout after preservation, so that when viewed directly from in front the tip of snout seems to be divided into four sections of equal size by the horizontal and vertical grooves, with the proboscis pore at their intersection.

Mouth is of large size, extending forward nearly as far as the posterior ends of the cephalic furrows and nearly to the annular constriction on head. Its length is 9 mm. in this specimen.

Color. — As preserved in alcohol color of body, except the head, is dark brown with a greenish tinge; head much paler, with numerous brown mottlings both above and below.

Serial sections of so gigantic a worm would obviously be too cumbersome to study as a series, and I have therefore not investigated the details of its internal anatomy. A section through esophageal region reveals an extremely massive outer longitudinal muscular layer $2\frac{1}{2}$ mm. in thickness, while the circular muscular layer is but $\frac{3}{4}$ mm. thick, and the internal longitudinal muscles much thinner. Lateral nerve cords are each more than half a millimeter in diameter. In intestinal region muscular layers are all comparatively thin; the median lumen of intestinal canal in middle portions of body meas-

ures 3 by 4 mm., from which the intestinal lobes extend laterally to a depth of 15 mm. on each side. So great measurements as these have never before been described for any species of nemertean.

Habitat. — The single specimen described above was dredged by the Albatross in the Gulf of California (Sta. 3001, 24° 55′ N. Lat., 110° 39′ W. Long.), at a depth of 33 fms. Bottom composed of fine gray sand and broken shells; temperature 64° F.

Micrura Ehrenberg.

Symbolae Physicae, Berlin, 1831.

This genus includes mostly moderately small, slender forms, generally less rounded posteriorly, and of rather more active habits than Lineus. Its most marked distinction from the latter genus is that the posterior extremity of the body is provided with a slender, usually colorless, muscular caudal cirrus. This is formed of a continuation of the muscular tissues and integument beyond the posterior end of the alimentary canal.

The proboscis is usually slender and comparatively weak; the proboscis sheath is sometimes considerably shorter than the body.

The species of Micrura are generally, though not always, more brightly colored and have more distinct markings than do those of Lineus. The vast majority of the species are provided with numerous ocelli, though some are blind. The head is slender, and not distinctly separated from the rest of the body. The lateral faces of the body are not provided with thin edges as in Cerebratulus, the intestinal region is not so much flattened, neurochord cells are present in comparatively few species, and none of the species are able to swim as do all species of Cerebratulus. The mouth is usually smaller than in Cerebratulus, and the intestinal lobes are not so deep.

Including four species which are described as new in the present paper, there are eight species of this cosmopolitan genus which are now known to occur in the regions included in this report. So far as I can determine none of these forms have been reported from other parts of the world.

23. Micrura nigrirostris Coe.

Harriman Alaska Expedition, **11**, p. 198, Pl. 17, figs. 7, 8, 1904.

Pl. 3, fig. 29.

The individuals of this species are beautifully and strikingly colored, and may be recognized by the following peculiarities: —

Body of small size, only moderately slender, rounded anteriorly, slightly flattened in intestinal region; head commonly a little wider than parts immediately following; tip of snout rather narrow, cephalic slits of moderate length; caudal cirrus was not found in the few individuals examined.

Ocelli wanting.

Length of the few individuals found 40–80 mm.; diameter 2–3 mm.

Color both above and below bright blood red, sometimes with a tinge of purplish. Head blood red in color, with a narrow, but very sharp and conspicuous, transverse band of white on dorsal surface near tip of snout (Pl. 3, fig. 29). Immediately in front of this is a narrow, blood red area bounded behind and laterally by the narrow white band, and in the middle of the red area, and situated on the exact tip of snout, is a small, rounded, dark brown or black spot. Color after preservation brownish, the terminal markings being still retained.

Proboscis has only two muscular layers, the inner longitudinal muscles being completely wanting. Circular muscles of proboscis sheath much thickened immediately in front of intestinal region, representing perhaps an indication of the inner circular muscles which are found in same region in several related species.

Cephalic glands well developed, extending posteriorly nearly to the brain.

Cephalic furrows are narrow, and are not deep. Except at their posterior ends, they reach less than half the distance from surface to rhynchodaeum or brain.

Alimentary canal. — The two divisions of the esophagus, described for *Lineus rubescens*, *L. flavescens*, and other forms, are also well marked in the present species. The change from esophagus proper to stomach is abrupt, and the two sections are

separated by a conspicuous sphincter of contractile tissue. The position of this sphincter is at about two fifths the distance from snout to intestinal region, and is in the immediate vicinity of the efferent nephridial ducts. The change from stomach to intestine is gradual, and the true intestinal pouches do not begin until after the appearance of a number of shallow pouches in the walls of the stomach.

Nephridia are very limited in extent, being confined to posterior half of esophageal region proper. The single pair of nephridiopores is situated at posterior end of nephridial system. *Proboscis sheath vessel* leaves rhynchocoel at the same place. Here, too, the esophageal lacunae unite into a pair of ventro-lateral vessels which pass back through the stomach region, and into which the lateral vessels empty at the beginning of the intestinal region.

Other details of anatomical peculiarities may be found in the paper cited.

Habitat.— San Pedro, California, among hold-fasts of kelp and other algae on rocks at low water; not common.

24. Micrura verrilli Coe.

Proc. Wash. Acad. Sci., **3**, p. 68, Pl. 5, figs. 1–3, 1901; Harriman Alaska Expedition, **11**, p. 68, 1904.

Pl. **3**, figs. 34, 35.

Body of moderate proportions, but compact and well rounded throughout, flattened only on ventral surface; head narrow, cephalic furrows rather long; no ocelli; mouth small; caudal cirrus whitish and slender; intestine opens posteriorly *above* the base of caudal cirrus. Length varies from 5 to 50 cm., more commonly 12 to 20 cm.; width 3–6 mm.

Color.— One of the most handsomely colored of all species of nemerteans; general color of body pure ivory white with a series of sharply defined rectangular markings of deep purple or wine color covering the greater portion of the dorsal surface (Pl. **3**, figs. 34, 35). These rectangular markings are surrounded by the white of body, and are separated from each other by very narrow, but sharply defined, white lines. They may be nearly as wide as

the body, or may be considerably narrower. In the latter case they are bordered laterally on the dorsal surface by a narrow band of white, continuous with that of the ventral surface. On dorsal surface of tip of snout is a very conspicuous triangular marking of bright orange color (Pl. 3, figs. 34, 35). Following this posteriorly is a narrow, transverse white line; then comes a series of broad purple rectangles and narrow white lines in succession. There are usually 20 to 40 of these rectangles. As a general rule, the second, fourth, and sixth rectangles are shorter antero-posteriorly than the first, third, fifth, etc. The comparative length of the rectangles is naturally dependent upon the state of contraction of the body.

Ventral and lateral surfaces of body pure white.

Proboscis of three muscular layers; with distinct crossings of fibers.

Nephridia extensive, occupying anterior two thirds of esophageal region, and provided with numerous (15 to 20 or more) efferent ducts.

For further details of anatomical peculiarities, see Coe, :01 or :04, pp. 68–70.

This handsome species is found quite commonly at Pacific Grove and Monterey, California. In addition to the description given in the paper quoted above, the following notes on the specimens found in California may be added. In general these individuals differ from those collected in Alaska in having the dorsal markings much narrower than the body, so that a narrow margin of ivory white color is seen on each side when the worm is viewed from the dorsal surface (Pl. 3, figs. 34, 35). Sometimes the purple markings are not more than three fourths or even one half as wide as the diameter of the body, and a few individuals in which the genital products were mature were observed to have the dorsal markings covering only the median third of the dorsal surface in the intestinal region. The lateral white color is more opaque than the white of ventral surface, and in it is a row of slightly grayish dots on each side in intestinal region. These apparently represent the genital pores, for they seem to be limited to the sexually mature individuals. They are sometimes quite conspicuous (Pl. 3, fig. 35).

Even in small individuals there are seldom less than 30 of the rectangular purple markings, while specimens attaining a length of

50 cm. may have rather more than 40. In many cases, however, the number may appear to be considerably less, due to a more or less complete fusion of several adjacent markings (Pl. 3, fig. 35).

An interesting case of regeneration of the posterior end of the body, in which it is clearly seen that the characteristic markings are laid down in miniature long before the regenerated portion attains its full size, is shown in Pl. 3, fig. 34. This process is thus apparently similar to that seen in the regeneration of distinctly segmented worms, such as the annelids.

Prof. C. B. Wilson describes in his notes the color of the body as bluish brown on dorsal surface with narrow transverse bars of white from 1 to 3 mm. apart; tip of snout bright vermilion; lateral and ventral surfaces white, which color also extends to lateral margin of dorsal surface. Found under large stones and among roots of eelgrass at Pacific Grove, California.

Mr. J. F. Abbott has kindly sent me a colored drawing of a somewhat contracted individual of this species from Pacific Grove, in which the genital pores are clearly shown (Pl. 3, fig. 35).

Sexual products mature in September in Monterey Bay. Ova large, opaque white.

Habitat.— Under stones; Pacific Grove, California. Common among kelp hold-fasts attached to stones on sandy bottom in about 2 fms., Monterey, California. In this situation the worms agree almost perfectly in color with the purplish processes of the kelp hold-fasts among which they are entwined. In such cases the worm may lie fully exposed among the purplish root-like processes of the kelp and yet escape detection until it begins to crawl or to move its bright orange snout. Few animals exhibit a more striking protective coloration, and yet they could scarcely be more conspicuously colored when removed from their natural surroundings. The worms are often found living in strong, parchment-like tubes, but whether they secrete them or take the tubes of *Carinella sexlineata*, with which they are often associated, is uncertain.

The species has previously been recorded only from Prince William Sound, Alaska (Coe, :01).

Griffin found very small specimens of a somewhat similar species (*Lineus striatus*) in Puget Sound ('98, p. 214), and Stimpson's *Cerebratulus* (=*Micrura*) *impressus* ('57, p. 160) from Bering Strait, and *Cerebratulus* (=*Micrura*) *bellus* from Yezo Island,

Japan, both bear a superficial resemblance to the above. The relationship of these species is discussed below.

25. Micrura impressa (Stimpson) Coe.

Cerebratulus impressus Stimpson, Proc. Phil. Acad. Nat. Sci., p. 160, 1857.

Micrura impressa Coe, Proc. Wash. Acad. Sci., **3**, p. 3, 1901.

Stimpson describes this species as being flattened, of a grayish brown color above, interrupted by narrow, colorless, transverse lines. Head small, subtruncate, much narrower than body, flesh color, with brown dots near antero-lateral margin. Length of body 3.8 inches, width .35 inch. Habitat, Bering Strait.

The same author describes a somewhat similar species (*C. bellus* = *Micrura bella*) from Yezo Island, Japan. This had 10 bluish white, narrow transverse lines across the ashy gray dorsal surface, and a white ventral surface. The head was short and of a vermilion color. Both these species should be referred to the genus Micrura as here defined.

Griffin ('98, p. 214) described a species (*Lineus striatus*) closely similar to the above, but also resembling *M. verrilli*. Griffin's specimens were brownish red dorsally, this color being sharply marked off laterally from the much lighter ventral surface. Dorsal surface crossed by numerous creamy white transverse bands, which cease at demarcation line between dorsal and ventral coloring. Tip of head brilliant red. Length probably not over 4 cm. Nephridia have numerous efferent ducts. Puget Sound.

I do not feel justified in uniting any of these forms with *M. verrilli*. They are all closely similar so far as can be judged by the brief descriptions given, and yet no two agree in color or arrangement of markings. Griffin states that his color notes and drawings were lost by shipwreck. Further collections in the localities indicated will doubtless determine whether a single species presents such marked color varieties, or whether two or more closely similar species occur in this region. I feel the more hesitation in uniting any of these forms with *M. verrilli*, because the descriptions and drawing of this species sent me by Mr. Abbott, as well as the

description given me by Professor Wilson, agree perfectly with the very numerous individuals of *M. verrilli* which I have collected in Alaska and California.

26. Micrura pardalis, sp. nov.

Pl. 3, fig. 31; Pl. 24, fig. 189.

A single specimen of this strikingly colored species was collected by Prof. C. B. Wilson at Pacific Grove, California. The natural colors are perfectly retained after short preservation in formalin. Wilson's notes on the living worm are incorporated in the following description: Body rather stout for genus, much flattened ventrally, a cross section resembling that of a plano-convex lens; body broad anteriorly, more slender toward posterior end. Head rather broad, not well differentiated from body (Pl. 3, fig. 31). Cephalic furrows of moderate length (Pl. 24, fig. 189).

Length of body of single individual collected about 3 cm.; width 3–5 mm.

Color. — General color of body clear, pale yellowish or cartilage color; ovaries chrome yellow, showing through on ventral surface as bright, separate, spherical masses. Dorsal surface thickly covered with black or very dark brown spots and dots of various sizes, often slightly elongated in longitudinal axis of body and very irregularly arranged in longitudinal lines (Pl. 3, fig. 31). Head and esophageal regions of a much clearer, paler yellow than that of intestinal region in the ripe female, owing to the chrome yellow color of the ovaries. Brain lobes indicated as pale reddish brown spots, visible mainly from ventral surface.

Ocelli.— The eyes are difficult to distinguish in life owing to the many black spots of color on the head. They can easily be demonstrated, however, after clearing the preserved specimen in some suitable reagent, when they are conspicuous from the ventral surface. A single irregular row usually consisting of 10 to 18 ocelli of rather small size lies on each lateral margin of head (Pl. 24, fig. 189). Several of the anterior ocelli are usually slightly larger than the others, and are often arranged in an irregular cluster of 3 to 6 on each side near tip of snout. The remaining ocelli are scattered

at irregular intervals in a marginal row on each side, which extends posteriorly about to the end of the corresponding cephalic furrow.

Proboscis sheath extends quite to posterior extremity of body.

Body walls.— Internal longitudinal muscular layer comparatively thin throughout whole length of body. Lateral nerves of unusually large size, and with remarkably distinct nerve plexus outside circular muscular layer in esophageal region. Cutis glands massed in a very dense layer, occupying outer half of outer longitudinal musculature.

Cephalic glands remarkably voluminous, occupying a great portion of tissues of head in front of brain, but not extending behind brain.

Alimentary canal.— Esophageal region differentiated into esophagus proper and stomach, characterized by peculiarities of epithelial lining as usual. Intestinal lobes very short, with a comparatively large central canal.

Nephridia are situated in middle third of esophageal region, and send numerous small branches among the esophageal blood lacunae. Two or more pairs of efferent nephridial ducts open on dorso-lateral surfaces of body.

The usual pair of large cephalic blood lacunae are united by a very broad anastomosis anteriorly.

Sense organs.— The three terminal or frontal sense organs are fairly well developed. Ocelli are situated deep in tissues of head. Cerebral sense organs remarkably large, intimately connected with dorsal ganglia and bathed in lateral blood lacunae as usual. Cephalic furrows moderately deep. Brain very large.

Reproductive organs.— Sexually mature in August. Ova yellowish in color, of large size, commonly not more than 6 to 10 in each pouch.

Habitat.— In crevices of ledges at extreme low water, Pacific Grove, California. Not common.

27. **Micrura olivaris**, sp. nov.

Body small, but comparatively short and stout, rounded anteriorly, flattened in intestinal region. Head rather broad, cephalic furrows extend as far back as anterior border of mouth. Posterior

extremity slender; caudal cirrus not found. Proboscis sheath very small in intestinal region.

Length 7 to 15 cm.; width 2 to 3 mm.

Color.— Pale olive brown, grayish ocher, or buff, with deeper olive in intestinal region and paler median dorsal stripe in esophageal region.

Ocelli.— A number of small black ocelli lie in an irregular, elongated cluster, or in a single irregular row, on each lateral margin of head. The number varies from 6 to 12 or more on each side.

Cephalic glands are remarkably highly developed. They are thickly massed among the other tissues in front of brain, although they cease entirely at anterior border of brain region.

Cutis glands proper are limited to the outer portions of the outer longitudinal muscular layer throughout the esophageal region proper, while in the stomach region they sink gradually deeper, until they extend completely through the outer longitudinal muscles and border the nerve plexus externally.

In addition to the cutis glands, which have a marked affinity for haematoxylin and always stain very deeply with this reagent, are peculiar accessory glands of large size and with very little staining capacity with haematoxylin, and which are scattered irregularly through the whole thickness of the outer longitudinal muscular layer. These resemble in many particulars the accessory buccal glands found in *Micrura alaskensis*, although their secretion is discharged to the surface of the body. They are most abundant in the anterior portion of the esophageal region, and are gradually superceded in the stomach region by the true cutis glands, which sink inward through the outer longitudinal muscles as stated above. They occur throughout the circumference of the body, and are filled with a distinctly granular secretion, which is not very different from that of some of the larger cutis glands of certain related species.

Alimentary canal. — Mouth very small; esophagus sharply demarcated from stomach, which, in the single individual sectioned, extends forward for a few sections beneath the posterior end of esophagus proper as a short cardiac caecum. It seems probable, however, that this caecum results from the strong contraction of the worm when killed, and that it would not appear when the

animal was well extended. The histological peculiarities of the various portions of the alimentary canal are perfectly similar to those described for *Lineus rubescens* (p. 165).

At the posterior end of stomach region and anterior to the first pair of intestinal lobes is a highly developed inner circular muscle similar to that described for ZYGEUPOLIA. It terminates abruptly after having attained its maximum development and extends anteriorly but a short distance.

In the same region occurs a corresponding thickening of the circular muscles both of the proboscis sheath and of the body walls.

Blood system.— The large, median cephalic lacuna divides into lateral lacunae, and these into a system of esophageal lacunae, as in related species. Behind the nephridial region the esophageal lacunae are again united into the lateral vessels.

Nephridia.— The nephridial canals extend from near the mouth nearly to anterior end of the stomach region. Anteriorly a number of slender branches ramify among the esophageal lacunae, but are soon gathered into a single longitudinal canal on each side. This canal has a few large branches and opens at its posterior extremity to the dorso-lateral surface of the body by an unusually large efferent duct. The pair of nephridiopores is thus situated a few sections in front of the anterior end of the stomach.

Nervous system and cephalic sense organs are as in related species in most particulars. The esophageal nerves, however, are peculiar in that they each branch soon after their origin from the ventral ganglia into two nerves of about equal size. One of these passes through the circular muscles of the body walls at the anterior border of the mouth region and takes up the usual position beneath the anterior portion of the esophagus. The other continues backward through the greater portion of the esophageal region proper directly beneath the lateral nerve, and therefore outside the circular muscles. In the stomach region the nerve is gradually fused in the general nerve plexus on the outer border of the circular muscles.

Reproductive organs.— Sexual products are mature in September. They develop in large pouches which largely obliterate the intestinal canal when fully mature.

Habitat.— Pacific Grove, California; among crevices of rocks at low water. Not common.

A single specimen indistinguishable from the above after preser-

vation was dredged by the Albatross off San Francisco, California, (Sta. 3478, 36° 44′ N. Lat., 120° 57′ W. Long.), in 68 fms., gray sand and mud.

28. Micrura alaskensis Coe.

Proc. Wash. Acad. Sci., **3**, p. 71, Pl. 4, fig. 2; Pl. 13, fig. 1, 1901; Harriman Alaska Expedition, **11**, p. 71, 1904.

This common Alaskan form has now been found to extend southward to the coast of California. It may be recognized by the following brief diagnosis:[1] Body long and moderately slender, attaining a large size for the genus, rounded in esophageal region, flattened in intestinal region; caudal cirrus well developed, but often broken; head remarkably slender, with correspondingly long, but very shallow cephalic furrows. Ocelli wanting. Length commonly 15 to 60 cm., although much smaller individuals are often found.

Color. — General color of body pale salmon, flesh color or deep pink, but this coloration is much interfered with by color of intestinal canal and by the sexual products when mature. Head pale flesh color or pinkish, sometimes nearly colorless; brain distinctly red; intestinal canal with its lateral lobes salmon, yellow or brownish; at time of sexual maturity much obscured by the cream colored or yellowish sexual products. A median longitudinal stripe of cream color, flesh color or pinkish, usually extends the length of the body on both dorsal and ventral surfaces, but is conspicuous only in the intestinal region, and is especially prominent at time of sexual maturity.

Buccal glands.— There are peculiar glands in the region of the mouth and just behind it which may be called accessory buccal glands, and which have been found in no other species. These extend through nearly the whole of the outer longitudinal muscular layer of the body walls ventral to the lateral nerves. Secretion from these glands is apparently discharged into the buccal cavity and anterior portion of the esophagus.

Cephalic furrows are very long, but are remarkably shallow, extending scarcely half the distance from surface of head to brain.

[1] For colored figure and details of anatomical structure, see paper cited.

Esophageal blood lacunae large and conspicuous, surrounding esophagus on three sides.

Nephridia consist of a single large longitudinal canal on each side in the middle esophageal region, which branches only in its anterior portions and has a single efferent duct at its posterior end.

Cephalic glands are but little developed; cutis glands are limited to outer portion of outer longitudinal muscular layer, except that for a short space near posterior end of stomach region they sink nearly to the circular muscles.

A remarkably well developed *inner circular muscle* surrounds the posterior portion of esophagus as in the preceding species, but ceases abruptly at the very beginning of intestinal region. The main circular muscular layer thickens very considerably in the same region.

Habitat.— Under stones between tides; common throughout southern Alaska as far west as Prince William Sound. Nearly 50 individuals, some of which were upwards of 30 cm. in length, were found twisted together in a tangled mass in a single cavity in coarse gravel at Sitka, Alaska. All were filled with ripe sexual products in June (Coe, **:01**, p. 74). Several individuals of large size, measuring 20 to 60 cm. each, when well extended, were collected by Mr. A. J. Carlson at Pacific Grove, California. In these the sexual products were immature, and the worms were deep, rosy flesh color or deep pink; paler and duller beneath. Color resembles that of *Paranemertes carnea* (Coe, **:01**, Pl. III, figs. 3, 4) very closely. Not common at Pacific Grove, and found only at extreme low water in crevices of rocks.

At San Pedro, California, the species is fairly common in certain sandy localities on the flats of the harbor at extreme low tide, but the specimens secured were but a small fraction of the length of the large individuals found farther north on the California coast. The average length at this locality was but 7 to 10 cm.

The present known range of the species is thus from San Pedro, California, to Prince William Sound, Alaska — a distance of about 2,500 miles.

29. **Micrura griffini**, sp. nov.

Body of rather large size for genus, rather slender, rounded in esophageal region, much flattened posteriorly, but without thin lat-

eral margins. Head rather slender, very changeable in shape; cephalic furrows correspondingly long, extending as far as anterior border of mouth; ocelli wanting. Caudal cirrus remarkably long.

Length up to 30 cm. when full grown; width 3 to 4 mm.

Color.— Esophageal region rosy, bright pinkish red, or dull red with tinge of purplish; head paler; snout nearly white, shading gradually into reddish color posteriorly; brain region deep pink. Intestinal region deep flesh color or pale reddish, with deeper red dorsal and ventral median longitudinal bands. When sexual products are mature intestinal region is yellowish, except in the median line. Proboscis long and slender, cream colored.

Body walls.— Cephalic glands diffused and not well developed. Cutis glands limited to a thin layer in the outer fourth of outer longitudinal muscular layer in esophageal region, sinking deeper into the musculature on the approach of the intestinal region, but little developed as compared with many related species. Accessory buccal glands wanting.

Inner longitudinal muscular layer remarkably thin, being scarcely one sixth the thickness of outer longitudinal muscular layer in esophageal region.

Alimentary canal.— Mouth of large size when distended. There is the usual division into esophagus proper and stomach.

Nephridial and blood systems.— The median cephalic lacuna which unites the lateral cephalic lacunae anteriorly is remarkably limited in extent. Lateral vessels and esophageal lacunae as in related species.

Nephridia unusually extensive, reaching anteriorly into the anterior fourth of esophageal region, and extending posteriorly nearly to the stomach region. A single pair of large canals with numerous branches extend the whole length of the nephridial region and open posteriorly on the dorso-lateral surfaces of the body as usual.

Sexual products are fully mature in July at San Pedro. The ripe eggs are beautifully clear and fine for study. They measure about 0.125 mm. in diameter. Polar spindles were quickly formed when the eggs were placed in sea-water, and would doubtless have developed by artificial fertilization had any males been secured at the same time as the females.

Habitat.— Representatives of this species were found only at

San Pedro, California, living in sand on the flats of the harbor. They are not common in the localities visited.

This form resembles *M. alaskensis* which is found in the same locality, but its deep reddish color and absence of accessory buccal glands will distinguish it from the latter. The resemblance to *M. leidyi* of the Atlantic coast is very close in size, form, habits and color. It differs, however, in size of caudal cirrus, color of proboscis, relations of cephalic blood lacunae, character of nephridia, and other minor peculiarities.

30. Micrura nebulosa, sp. nov.

Body of small size, rounded, thickest in anterior portions after preservation; head broad, not demarcated from body; cephalic furrows of moderate length, joining proboscis pore in front when head is partially contracted; mouth small, situated as far back as posterior ends of cephalic furrows.

Length of single preserved specimen 25 mm.; width 2 mm.

Color.— In the preserved specimen the color resembles that of the dorsal surface of *Amphiporus nebulosus* (Coe, :01, Pl. 4, fig. 1). The whole surface of body both above and below is thickly mottled with coarse brownish blotches on a grayish ground color. Posteriorly the blotches fuse together to form a nearly continuous brownish color, through which the grayish ground color appears only at intervals.

Ocelli apparently wanting.

Proboscis sheath peculiar in that its internal longitudinal muscles are represented by two broad bands on ventral side instead of forming a complete cylinder as in related species. The rhynchocoel vessel, which is of remarkably large size, lies between these two muscular bands. The sheath does not reach quite to posterior end of body.

Cephalic glands very abundant, occupying tissues of head inward nearly to rhynchodaeum. They are thickest, however, in dorsal half of head, and cease entirely some distance in front of brain.

Cutis glands mostly limited to outer half of outer longitudinal muscular layer.

Inner circular muscles very highly developed, becoming for a very short distance immediately in front of intestinal region nearly

as thick as the main circular layer. Integumental muscles conspicuous. Outer longitudinal muscular layer nearly disappears toward posterior end of body, but inner longitudinal muscles remain as a well developed layer to the very end of body.

Alimentary canal shows the usual division into esophagus proper, stomach, intestine and rectum.

Nephridia extend through whole of region of esophagus proper, reaching forward as far as the mouth. In their anterior portions numerous fine branches lie on the lateral walls of the blood lacunae, but farther back unite into a single large longitudinal canal on each side, which is situated close beside the proboscis sheath. Near its posterior end the canal becomes much smaller and opens by a single efferent duct to the dorso-lateral surface of body at about the region where the esophagus enters the stomach.

Sense organs.— Frontal sense organs present, but not highly specialized. Cephalic furrows very shallow, not reaching half the distance from surface to rhynchodaeum. Cerebral sense organs highly developed, connected with dorsal ganglia by very large nerve cores.

Habitat.—A single specimen was dredged by the Albatross south of Alaska Peninsula (Sta. 3210, 54° 00′ N. Lat., 162° 40′ W. Long.) at a depth of 483 fms., the bottom being composed of sand and green mud. Bottom temperature, 38.5° F. This is the greatest depth at which any of the nemerteans of these collections were obtained, and is much greater than that at which nemerteans are usually found, although a number of forms have been taken at even greater depths. Species of MICRURA are the most common of these abyssal forms.

Cerebratulus Renier.

Prospetto della Classe dei Vermi, 1804.

The species of this genus are distinguished by long, flattened bodies, the lateral margins of which are thin, adapted for swimming. Most species are very active, swim readily with undulatory motion, can roll up spirally and become twisted, but are only moderately contractile in length, and do not draw together into a tangled mass. The dorso-ventral musculature is highly developed, as are likewise the longitudinal and oblique muscles.

Head usually pointed anteriorly, but very changeable in shape;

lateral slits long and deep; proboscis pore terminal; mouth large, and situated behind the ganglia; esophageal region mostly rounded; intestinal region broad and flat with thin lateral margins; the posterior end extremely flattened and provided with a delicate caudal cirrus, which extends ventrally beyond the opening of the intestine, and in most species is easily broken off. Eyes often wanting. Body commonly of a nearly homogeneous color, without distinct markings (such as longitudinal and circular bands and rings).

Proboscis sheath reaches to posterior end of body; proboscis very long and strong. Intestinal pouches deep and mostly forked peripherally; central intestinal canal comparatively narrow. Neurochord cells probably commonly present in brain and lateral nerve cords, though they have as yet been found in but few species.

Ten species of this cosmopolitan genus are described on the following pages as occurring in the region covered by this report. But a single one of these (*C. marginatus*) has been found in other parts of the world. Four species are described as new.

31. Cerebratulus herculeus Coe.

Proc. Wash. Acad. Sci., **3**, p. 75, Pl. 1, fig. 5, 1901; Harriman Alaska Expedition, **11**, p. 75, 1904.

Pl. **3**, fig. 32.

Representatives of this species attain gigantic proportions and are among the largest nemerteans known. Fully mature individuals are often more than 2 meters in length and more than 25 mm. in width. The body is comparatively short and thick, except when fully extended; the head is very short, thick and bluntly pointed, cephalic furrows short (Pl. **3**, fig. 32), mouth large. Esophageal region very short, rounded; caudal cirrus comparatively small; proboscis large, colorless; ocelli wanting.

Color dark brown or reddish brown (Pl. **3**, fig. 32), somewhat less bright on ventral surface.

In spite of their great size, the worms are not clumsy, but swim gracefully and rapidly and move actively through their burrows.

Habitat.— Sitka, Alaska (Coe, :**01**, p. 75), in soft mud, associated with *C. marginatus*; southern Alaska (Griffin, *C.* sp.?, '**98**, p.

217); Mr. Abbott informs me that he has seen specimens which were collected at Kadiak, Alaska.

32. Cerebratulus marginatus Renier.

Tavole per servire alle classificazione degli animali, Padova, 1807.

C. angulatus McIntosh, British Annelids, Pt. 1. Nemerteans, p. 195, Ray Society, 1872–73.
C. fuscus Verrill, Trans. Conn. Acad., **8**, p. 438, 1892.
C. marginatus Bürger, Fauna u. Flora von Neapel, p. 660, 1895.

Text-figs. 29, 30.

The worms of this species may be recognized by their large, stout bodies which are rounded anteriorly, but flattened and with very thin lateral margins in intestinal region; ocelli wanting; length often 50 cm. to 1 meter; cephalic furrows large and deep, of moderate length; color grayish, greenish gray, slate color, pale brownish or dark slaty brown, sometimes mottled on dorsal surface, but usually paler beneath (sometimes very pale), and usually with very pale or whitish lateral margins.[1] The colors are well retained after preservation. The worms are excellent swimmers and move rapidly in their burrows.

Habitat.—Characteristic individuals 50 cm. to a meter in length are fairly common in mud in San Pedro Harbor, California, at low water. Also dredged in 3–5 fms. in channel, San Pedro.

Some individuals are very pale, especially on the ventral surface, while others which are decidedly dark on dorsal surface are pale grayish ventrally. They apparently all belong to the one widely distributed species, however, their internal anatomy agreeing with that of *C. marginatus* from Naples. In many individuals the pale color on the lateral margins is wanting.

The species has previously been collected on the Pacific coast by Griffin in Puget Sound ('98) and by myself at Sitka, Alaska (:01). From this latter locality the worms were comparatively broader and shorter than those from San Pedro or from Naples, and lived in soft black mud.

[1] For colored drawings of living worms and description and figures of anatomical peculiarities, see Bürger ('95).

A large specimen which must have been fully a meter in length when alive, and which is 15 mm. in width after preservation, was collected by Dr. D. S. Jordan at Santa Barbara, California.

The species was also collected by the Albatross off central California (Sta. 3203, 36° 48′ N. Lat., 121° 53′ W. Long.) in 138 fms., brown mud. Bottom temperature 45° F. One specimen of medium size.

Besides its range on the Pacific coast, at least from San Pedro, California, to southern Alaska, the species is found in the Mediterranean, on the coasts of Great Britain, Madeira, Greenland, the northeastern coast of America, and in other localities.

33. **Cerebratulus signatus**, sp. nov.

Pl. **4**, figs. 42, 43.

Body of moderate size, rather thick and short after preservation, of greatest diameter just behind mouth and tapering gradually toward narrow posterior extremity (Pl. **4**, fig 42); lateral margins very thin in intestinal region, continuing forward as sharp ridges as far as posterior ends of cephalic furrows; head not demarcated from body after preservation, acutely pointed anteriorly and flattened dorso-ventrally; cephalic furrows short, but deep and conspicuous (Pl. **4**, fig. 43); mouth small, situated as far back as posterior ends of cephalic furrows.

Length of single preserved specimen 55 mm.; width 6 mm.

Color.— Indications of characteristic markings are still visible on the preserved specimen, although the coloring in life is unknown. As shown in Pl. **4**, fig. 42, there is a conspicuous narrow band of dark color (brown in specimen) extending whole length of body in the median dorsal line. This dark band does not extend forward quite to tip of snout and is interrupted near posterior extremity of body. On each dorso-lateral surface of body is a series of narrow transverse markings of similar brown color, placed side by side and situated about midway between lateral margins of body and dorso-median band. It is uncertain whether these markings extend to posterior end of body, for they are visible only in the anterior half of this specimen. Ventral surface is probably without definite markings.

Proboscis remarkably large and strong; provided with a pair of very large nerves, which arise from ventral brain lobes near the commissure and pass forward to enter the ventral side of the proboscis at its attachment immediately in front of the brain; they then spread out to form a remarkably conspicuous plexus, situated directly beneath the internal epithelium. There are but two distinct layers of muscles, an internal longitudinal musculature being wanting. The circular layer, however, shows an indication of two layers, the outer half being composed of fibers which run somewhat diagonally to those of the inner half of the layer. The muscular crosses are well developed.

Body walls.— Cutis remarkably thin, its glands extending inward for only about one sixth to one fourth the distance from surface of integument to circular muscular layer. Outer longitudinal musculature much thicker than the other two muscular layers combined; it projects laterally beyond lateral nerve to form an acutely pointed lateral ridge, or keel, the muscles being several times as thick in this region as elsewhere on the circumference of the body. Inner longitudinal musculature very thin, in many places being less than one tenth as thick as the outer longitudinal muscular layer.

Blood and nephridial systems.— A single pair of large lacunae in the head unite anteriorly above the rhynchodaeum as in many related species. Esophageal lacunae remarkably large, surrounding esophagus on all sides except dorsally.

The nephridia extend forward nearly to the mouth as profusely branched tubules lying on the lateral borders of the esophageal blood lacunae. Anteriorly most of the tubules lie above the level of the lateral nerves, but extend ventrally thereto in the middle nephridial region. Posteriorly all the tubules collect into a single large longitudinal canal on each side, at the posterior end of which a single large efferent duct opens to the exterior on the dorso-lateral surface of the body. The position of the pair of nephridiopores is at about one third the distance from mouth to intestinal region.

Nervous system and sense organs.— All the nervous structures of the body are remarkably conspicuous. The lobes of the brain and their commissures, the esophageal, proboscidial, and dorso-median nerves, as well as the plexus outside the circular muscles of the body, are all remarkably well developed.

The cerebral sense organs are unusually large, their glandular

posterior ends projecting freely backward into the lateral blood lacunae. The cephalic furrows cut into the tissues of the head almost to the position of the brain; in their posterior portions they are surrounded by a thick layer of small nerve cells; they do not end posteriorly at the exit of the canal leading to the cerebral sense organs, but continue for some distance farther back. The frontal sense organs are very inconspicuous.

Habitat.—The single specimen represented in these collections was dredged by the Albatross in Bering Sea, August 16, 1890 (Sta. 3318; 53° 47′ N. Lat., 167° 14′ W. Long.) at a depth of 61 fms. Bottom composed of black sand, gravel, and shells; temperature 42° F.

34. **Cerebratulus lineolatus**, sp. nov.

Pl. 4, fig. 44.

Body rather slender but of ordinary proportions for genus; head slender and acutely pointed, not demarcated from body; cephalic furrows moderately long and very deep, although they extend hardly as far posteriorly as the very large mouth. After preservation both head and body may become comparatively short, the thickest portion of body being immediately behind mouth (Pl. 4, fig. 44).

Length 25 mm. to 20 cm.; width 2–7 mm.

Color.— General color of body pale gray with numerous fine, irregular and much interrupted dark olive brown longitudinal lines extending the length of the body both above and below, but more numerous and larger on dorsal surface than ventrally. There are perhaps 12 of these fine lines, which are often discontinued and often united with adjacent lines (Pl. 4, fig. 44). On the head series of elongated dots take the place of definite lines, and in some individuals this is the case over the whole body. The markings have a certain resemblance to those of *Eupolia lineolata* Bürger ('96, Pl. 11, Fig. 8). Some individuals resemble *Taeniosoma delineatum* rather closely in color. Brain is conspicuous both above and below by its reddish color, which shows through the translucent tissues of the head.

Markings sometimes entirely disappear after preservation, but in

other specimens are retained for some months in formalin as fine irregular lines and rows of dots, especially on dorsal surface. In a single large specimen which has been kept for 25 years in alcohol the interrupted brownish lines are still conspicuous on dorsal surface of body.

Ocelli.— Usually 6 to 10 ocelli are placed at fairly regular intervals on each side of head near tip of snout, and a number of other irregular pigment spots are scattered back toward the brain region.

Body walls.— Cutis glands are limited to a comparatively thin layer in outer third of outer circular muscular layer. Internal longitudinal muscles are thin anteriorly, but increase considerably in thickness in posterior esophageal region.

Alimentary canal.— Esophagus divided into esophagus proper and stomach as usual. Intestinal lobes very short, with large central intestinal canal.

Nephridia.— Nephridial canals extensive, occupying the second and third fifths of esophageal region. There are usually 3 to 5 pairs of efferent nephridial ducts which open dorso-laterally.

Sense organs. — Cerebral sense organs large; cephalic furrows are long and deep, and are peculiar in that they extend for about half the diameter of the cerebral sense organs posterior to the origin of the ducts leading to the sense organs.

Habitat.— Dredged in about 5 fms. among shells on muddy bottom in San Pedro Harbor, California; not common. Sexually mature in August. A single specimen about 20 cm. in length was collected by the Albatross at San Diego, California, March, 1878.

35. **Cerebratulus occidentalis** Coe.

Proc. Wash. Acad. Sci., **3**, p. 76, Pl. 6, fig. 3, 1901; Harriman Alaska Expedition, **11**, p. 76, 1904.

This species can be recognized by the following peculiarities:— Body only moderately slender, commonly 15–30 cm. or more in length, much flattened posteriorly, head of moderate proportions, cephalic furrows rather short; ocelli wanting; proboscis is especially remarkable on account of its very small size as compared with that in related species.

Color usually chestnut brown or reddish brown anteriorly, and

light chocolate brown in intestinal region; ventral surface brownish flesh colored or light chocolate, with a median ventral stripe of ocher.

Cephalic glands well developed; brain remarkably voluminous; nephridia situated in middle third of esophageal region, with a single efferent duct on each side; sexual products mature in July.

Habitat.— An active species found abundantly in muddy localities beneath stones at half tide and below; southern Alaska to Prince William Sound (Coe, :**01**). Collected also by Mr. Shearer at Vancouver Island, B. C., and by the Albatross in Bellingham Bay, Washington, in green mud at a depth of 11 fms.

The present known range of the species is, therefore, from the State of Washington to Prince William Sound, Alaska.

36. Cerebratulus albifrons Coe.

Proc. Wash. Acad. Sci., **3**, p. 82, Pl. 4, figs. 3, 4, 1901; Harriman Alaska Expedition, **11**, pp. 82, 200; Pl. 18, fig. 9, 1904.

Body long and ribbon-like, much flattened and with thin margins in intestinal region, rounded anteriorly, much as in *C. marginatus*; cephalic furrows long and deep; ocelli wanting.

Length 15–30 cm. or more; width 3–6 mm.

Color of body ranges from dark brown with a tinge of purple, to brownish purple, slaty or black; often with a more reddish median band, due to position of proboscis sheath. Thin lateral margins of intestinal region often paler in color. Anterior portions of head pure white, both above and below, for about three fourths the distance to posterior ends of cephalic furrows; sometimes white border continues quite to ends of furrows, and reaches anterior end of mouth, but this is not usually the case. Proboscis pinkish when extended. Margins of mouth grayish.

Habitat.— The type specimen was found under a stone at low water, Sitka, Alaska (Coe, :**01**). The species occurs sparingly in mud, San Pedro, California; off San Pedro in 2–20 fms.; between San Pedro and Santa Catalina Island in 50 fms. (Coe, :**04**). Also dredged by the Albatross in 53 fms., fine gray sand and mud, off the coast of southern California (Sta. 2902, 34° 06′ N. Lat., 120° 02′ W. Long). Another specimen was taken by the Albatross in fine

sand and mud off central California (Sta. 3138, 36° 55′ N. Lat., 122° 02′ W. Long.) at a depth of 19 fms. The known range of this species is therefore from southern California to Sitka, Alaska, and its known range in depth is from low water to 53 fms. The worms are excellent swimmers and are very restless in confinement.

37. Cerebratulus longiceps Coe.

Proc. Wash. Acad. Sci., **3**, p. 77, Pl. 5, figs. 4–7, 1901; Harriman Alaska Expedition, **11**, p. 77, 1904.

Body much flattened throughout; head and anterior portions of body remarkably slender and much flattened; head very long, acutely pointed; cephalic furrows remarkably long, wide and deep; mouth situated opposite posterior ends of cephalic furrows; ocelli apparently wanting. Body very fragile, usually much broken when killed.

Length 15 to 30 cm.; width in intestinal region 3–5 mm.

Proboscis slender and colorless; with three muscular layers and the usual muscular crosses.

Color brownish black or purplish throughout body, except for slight grayish tinge on ventral surface; paler on tip of snout and on borders of cephalic furrows.

Nephridial system presents several striking peculiarities. It extends through whole length of esophageal region and possesses upward of *sixty* efferent ducts on each side. Immediately behind the mouth are one or two pairs of nephridial tubules which are quite independent of the rest of the system, each consisting of a coil of fine canals lying on the dorsal side of the lateral blood lacuna and projecting freely into its cavity. From each of these tubules an efferent duct leads to dorsal surface of body. Posterior to these isolated nephridia is a richly branched system continuous throughout the whole length of the esophageal region. The finer branches project into the cavities of the blood lacunae and encroach greatly upon their area. The very numerous efferent ducts vary greatly in size, some being several times as large as others. They are disposed with great irregularity, two or three ducts sometimes appearing on the same side in a single section, some being situated much nearer the dorso-median line than the others. The anterior, isolated

nephridia are particularly interesting in that they seem to represent a very primitive condition, such as is found in the planarians.

Sense organs.—Frontal sense organs highly specialized; cerebral sense organs as in related species; cephalic furrows long and deep, widely expanded posteriorly.

Reproductive organs.—Sexually mature in July. Ova develop on narrow stalks attached to wall of ovary and later break off and fall into the ovarian cavity, as Wilson (:00, p. 123) has described for *Cerebratulus lacteus.*

Habitat.—The species is known only from Yakutat, Alaska, where it occurs under stones at low water, but is not common.

38. Cerebratulus montgomeryi Coe.

Proc. Wash. Acad. Sci., **3**, p. 80, Pl. 6, figs. 1, 2, 1901; Harriman Alaska Expedition, **11**, p. 80, 1904.

Pl. **3**, figs. 38, 39.

This very large and brilliantly colored nemertean occurs abundantly along the whole Pacific coast of Alaska and in the Bering Sea, and may be easily recognized by the following peculiarities: Body large, very long and ribbon-like when well extended, much flattened except in esophageal region; head rounded and obtuse or pear-shaped and acutely pointed according to state of contraction; cephalic furrows moderately long; ocelli wanting.

Length commonly 50 cm. to two meters; occasionally up to two and a half or three meters when fully extended; width 8 to 17 mm.

Color.—Bright blood red throughout body, except tip of snout, which is white or yellowish white both above and below (Pl. **3**, figs. 38, 39).

Proboscis pale red, of moderate size, inner longitudinal muscles wanting. *Cephalic glands* well developed. *Nephridia* limited to anterior half of esophageal region, with a single pair of efferent ducts at posterior end.

Habitat.—This magnificent species has already been recorded from Puget Sound, and from various localities along the Alaska coast to the Aleutian Islands (Coe, :01, p. 82), where it is common in muddy locations, beneath stones near low water mark.

It is very abundantly represented in the collections at hand, having been dredged at the following localities: —

1. Port Angeles, Washington. One specimen apparently of this species collected by the Albatross, 1891.

2. Near Kadiak Island, Alaska. Collected by the Albatross (Sta. 2855, 57° N. Lat., 153° 18′ W. Long.) in 69 fms. Bottom green mud; temp. 44° F.

3. South of Alaska Peninsula. Collected by the Albatross (Sta. 3216, 54° 20′ N. Lat., 163° 37′ W. Long.) in 61 fms. Bottom black sand and mud; temp. 38.5° F. A number of very large specimens some of which may have been 3 meters in length when alive, and now measure 17 mm. in width and 15 mm. in thickness in esophageal region.

4. Unalaska Island, Alaska. One specimen collected by the Albatross.

5. Agattu Island (52° 30′ N. Lat., 173° 30′ E. Long.), Aleutian Group. One specimen of medium size collected by the Albatross.

6. Bering Sea. Several large specimens collected by the Albatross (Sta. 3311, 53° 59′ N. Lat., 166° 29′ W. Long.) in 85 fms. Bottom green mud; temp. 41° F.

7. Bering Sea. Two medium sized specimens collected by the Albatross (Sta. 3289, 56° 44′ N. Lat., 159° 16′ W. Long.) in 16 fms. Bottom black sand.

8. Plover Bay, Siberia (near Bering Strait). A single large specimen dredged by Mr. Bailey in 6 fms.

The present known range of this species is therefore from Puget Sound, along the Pacific coast of Alaska and the Aleutian Islands, through the Bering Sea to the vicinity of Bering Strait, a distance of more than 3000 miles. Its geographical distribution is thus from about 125° W. Long. to 173° E. Long., and from about 48° to 64.5° N. Lat.

39. Cerebratulus californiensis, sp. nov.

Body of form most characteristic of genus, rounded in esophageal region, much flattened and with very thin margins in intestinal region. Head of variable shape, as in many species of genus, commonly pear shaped or broad lanceolate, pointed anteriorly and constricted just back of brain, so that in ordinary states of contraction

head is broader than neck. Cephalic furrows moderately long, very deep, with thin margins; when anterior margin of head is somewhat contracted, cephalic furrows meet in front above proboscis pore. Caudal cirrus small but conspicuous, and not as readily broken off as in many related species. Ocelli wanting.

Body remarkably fragile even when sexual products are very immature, so that the living worms can seldom be handled without the body becoming ruptured.

Length 10–15 cm. or more; width 4–5 mm. in intestinal region.

Color. — Dull or rosy flesh colored or cream colored anteriorly; head paler and more translucent, except brain, which is dull red or wine color. Lateral margins in intestinal region thin, pale gray, and bordered internally by a conspicuous reddish line indicating position of lateral nerves. On dorsal surface proboscis sheath is indicated by a more reddish color.

Intestinal region less rosy, more nearly cream colored or of a pale buff color. Proboscis pale buff or grayish.

When preserved in formalin, color completely disappears in a day or two, except the darker tint of the brain which is retained for some days longer.

Proboscis of moderate proportions. Internal longitudinal muscular layer wanting, the basement layer of epithelium resting directly upon the nerve plexus. Muscular crosses between circular muscular layer and the very thin layer of circular muscles beneath the outer, flattened epithelium very conspicuous on both dorsal and ventral sides.

Cephalic glands well developed, extending through all parts of the tissues of head in front of brain. Cutis glands limited to outer portion of outer longitudinal muscular layer.

Alimentary canal.— Esophagus clearly exhibits the usual division into two chambers, esophagus proper and stomach, lined with differentiated epithelium.

Blood and nephridial systems.— A large median blood lacuna near tip of snout extends backwards for some distance toward brain before dividing into the two usual lateral lacunae. Extensive esophageal lacunae surround anterior portions of esophagus on three sides. Somewhat behind the nephridial region these are gathered into the lateral vessels which are found in the stomach region, and which are much smaller and have stronger walls than

the lateral vessels of the esophageal region proper. Proboscis sheath vessel passes through ventral wall of sheath shortly behind nephridial region.

Nephridial tubules ramify among the esophageal lacunae in the second and third fifths of the esophageal region. Its finer tubules are gathered into a single large branching canal on each side, which passes posteriorly to open on dorso-lateral surface of body by a single efferent duct in about the middle of the esophageal region.

Nervous system and sense organs.— Two or more pairs of large neurochord cells lie on the internal faces of the ventral ganglia, as in many other species of the genus. Cephalic nerves in front of brain remarkably well developed, although there are no ocelli. Cephalic furrows remarkably deep, reaching inward nearly to the brain.

Habitat.— Collected in mud near low water at San Pedro Harbor, California; Dead Man's Island, San Pedro; San Diego, near Point Loma, California. Not common.

A single specimen apparently belonging to this species was collected by the Albatross near Santa Barbara Islands, California (Sta. 2840) in 28 fms., green mud.

This is one of the most fragile species of nemertean found on the coast, nearly all of the specimens becoming fragmented as soon as collected. The worms swim actively when disturbed.

40. **Cerebratulus latus**, sp. nov.

Pl. **4**, Fig. 41.

Body remarkably short and broad for genus, much flattened throughout, with unusually thin lateral margins; very much broader than *C. marginatus*, *C. lacteus*, or related forms; broader also than those species related to *C. fuscus*, and of different proportions, being largest anteriorly and tapering gradually toward posterior extremity (Pl. **4**, fig. 41). Resembles *C. marginatus* somewhat closely in general color of body, but is far shorter, broader and more flattened both in life and after preservation.

Length varies enormously according to state of contraction of body; large specimens measure about 30 cm. in length and 25 mm. in width when moderately extended. One specimen which measures after preservation 29 mm. in width is but 18 cm. in length.

Head directly continuous with body, and there is likewise no demarcation between esophageal and intestinal regions, the thin lateral margins of body extending forward to posterior ends of cephalic furrows. Head very broad, the mouth being situated between posterior ends of cephalic furrows, and in preserved specimens almost as near to tip of snout as to posterior end of either cephalic furrow. Cephalic furrows remarkably short, measuring but 4 mm. in length in a preserved specimen whose width is 27 mm. in intestinal region; they are thus about one seventh as long as the greatest width of body (Pl. 4, fig. 41).

Esophageal region very short, much flattened, scarcely twice as long as width of body, with very thin lateral margins continuous with those of intestinal region. Even in esophageal region strong, flattened bands of dorso-ventral muscles pass at regular intervals beside proboscis sheath and esophagus from dorsal to ventral side of body.

Intestinal region very flat, with powerfully developed bands of dorso-ventral muscles between the intestinal lobes. Internal longitudinal muscles of body walls but very little developed. Lateral margins of body extremely thin, extending laterally beyond the lateral nerve cords on each side for a distance equal to nearly one fifth the width of body, or much more than half as great as the dorso-ventral thickness of body in same region. In a rather large specimen the width of intestinal region after preservation measures 27 mm., while its thickness is but 7 mm. Intestinal region commonly remains concave on ventral surface, with a distinct longitudinal ridge beneath each of the lateral nerves; from this point out the lateral margins are extremely thin.

Body tapers gradually towards posterior end, where the lateral margins are even thinner than more anteriorly and are produced as broad lateral fins (Pl. 4, fig. 41).

I know of no other species of the genus in which the worms are so well adapted for swimming as in the species at hand, and experience with living individuals on the coast of Alaska has demonstrated how actively and tirelessly they can propel themselves through the water. It seems not unlikely that they often leave their burrows to swim free in the water.

Proboscis of remarkably large size, although inner longitudinal muscular layer is practically wanting. Muscular crossings well developed.

Color.— Living specimens collected at Sitka, Alaska, were brownish in color throughout the whole body. As a rule they are of a paler brown than individuals of *C. marginatus*, which they somewhat resemble in color. Ventral surface is pale brown, as are also the thin lateral margins of body. They are decidedly paler in color than individuals of *C. herculeus*, and the shape of the body and the activity of the worms will readily distinguish these three species, which are all found in the vicinity of Sitka, Alaska.

Specimens preserved in alcohol lose their original coloring in a few months. The form and size of the body with its remarkably thin lateral margins will, however, readily serve to distinguish preserved specimens from those of any other species yet recorded from the region.

Habitat.— Collected on the Harriman Expedition in hard mud at low water, Sitka, Alaska. Dredged by the Albatross in the following localities:

1. Sta. 3173. Off Central California (Lat. 38° 19′ N., Long. 123° 14′ W.) in 62 fms., mud. Bottom temperature 48° F.
2. Sta. 2872. Off Cape Flattery, Washington (Lat. 48° 17′ N., Long. 124° 52′ W.) in 38 fms., gray sand. Bottom temperature 45.5° F.
3. Sta. 3068. Puget Sound, Washington (Lat. 47° 35′ N., Long. 122° 27′ W.), in 135 fms., green mud.
4. Sta. 3216. South of Alaska Peninsula (Lat. 54° 20′ N., Long. 163° 37′ W.) in 61 fms., black sand and mud.
5. Sta. 3311. Bering Sea, near Unalaska Island (Lat. 53° 59′ N., Long. 166° 29′ W.), in 85 fms., green mud. Bottom temperature 41° F.
6. Sta. 3313. Bering Sea, near Unalaska Island (Lat. 54° 01′ N., Long. 166° 27′ W.), in 68 fms., fine black sand. Bottom temperature 43° F.
7. Sta. 3314. Bering Sea, near Unalaska Island (Lat. 54° 02′ N., Long. 166° 32′ W.) in 74 fms., black sand. Bottom temperature 42° F.
8. 3521. Bering Sea, north of Pribilof Islands (Lat. 59° 09′ N., Long. 170° 48′ W.), in 40 fms., green mud and fine sand. Bottom temperature 31.9° F.

?[9. Plover Bay, Siberia. Proboscis only, but its large size indicates that it may have belonged to an individual of this species.]

These collections indicate that the species is common in the colder waters off the Pacific coast from central California to Bering Sea. The range in depth is from low water to 135 fms. The temperature of the bottom in these localities ranges from 48° F. off California down to 31.9° F. in Bering Sea, even in the month of August.

This is evidently therefore an arctic form which extends southward in the cold water at a depth of a number of fathoms as far as the region off the coast of central California, and is found only occasionally at low water on the Alaskan coast, for it occurs but once in the shore collections.

Emplectonema Stimpson.

Emplectonema Stimpson, Proc. Phila. Acad. p. 163, 1857.
Nemertes McIntosh, British Annelids, Part 1. Nemerteans, Ray Society, 1872–1873.
Eunemertes Vaillant, Hist. Nat. des Annelés, **3**, Paris, 1890.

Body very long and slender, varying greatly in thickness according to state of contraction, but most commonly considerably flattened; often sharply bent and folded into an irregular mass; integument provided with an unusual abundance of mucous secretion; proboscis and mouth opening together on subterminal portion of snout; proboscis sheath limited to anterior third of body; proboscis slender and very short, often not more than one sixth the length of body; a large number of minute eyes usually present; cerebral sense organs situated well in front of brain, and usually very small. The species are of sluggish movement, and many of them are found very near high-water mark among mussels, barnacles, rockweeds, etc.

Of this genus two species have previously been recorded from the west coast of America. To these a third species, *E. purpuratum*, is added in the present paper. Two of these forms have been found nowhere else in the world; the other (*E. gracile*) occurs also on the coasts of Europe and is widely distributed in the Northern Hemisphere, although it has not been found on the east coast of America.

41. Emplectonema gracile (Johnston) Verrill.

Nemertes gracilis Johnston, Mag. Zool. and Bot. **1**, p. 534, Pl. 17, Fig. 1, 1837.
Emplectonema viride Stimpson, Proc. Phil. Acad., p. 163, 1857; Griffin, Ann. New York Acad. Sci. **11**, p. 207, 1898.
Eunemertes gracilis Vaillant, Hist. Nat. des Annelés, **3**, Paris, 1890.
Eunemertes gracilis Bürger, Fauna u. Flora des Golfes von Neapel, Monogr. 22, Nemertinen, p. 543, 1895.
Emplectonema gracilis Verrill, Trans. Conn. Acad., **8**, p. 413, 1892.
Emplectonema gracile Coe, Proc. Wash. Acad. Sci., **3**, p. 23, 1901; Harriman Alaska Expedition, **11**, p. 23, 1904.

Pl. **1**, figs. 14, 14*a*, 15, 15*a*; Text-fig. 32.

This species may be easily recognized by the following characters:[1] — Body long and slender, somewhat flattened below, irregular and ungraceful in form; head slightly broader than rest of body. Length 20 to 50 cm. or even more; width about 2 mm. Color uniform, dark green or yellowish green above, and pale yellowish green or nearly white beneath (Pl. **1**, figs. 14, 15); ocelli in two groups on each side of head, consisting of a marginal row of 8–10 ocelli on each antero-lateral border of head, and a pair of more posterior, cerebral clusters with 10–20 ocelli each; basis of central stylet of proboscis long and slender, two to three times as long as the stylet itself, which is very slender, acutely pointed and gracefully curved like a sabre or scythe; each of the two accessory pouches contains 5–7 slender, curved stylets exactly similar to the central stylet in shape and size (Text-fig. 32).

Habitat.— These worms were found in the greatest abundance on the Harriman Expedition at nearly all the collecting stations between Victoria, B. C., and Dutch Harbor, Unalaska Island. They occurred everywhere along the shore and were most plentiful near high-water mark, crawling over the thick growth of mussels and seaweeds. Often a number of individuals were found coiled together in a single slimy mass, and on being disturbed would crawl apart and

[1] For descriptions and figures of anatomical peculiarities, see Bürger ('**95**, p. 543).

move sluggishly about, but usually made no effort at concealment. Similar masses were met with under stones in very muddy localities, and often where the water was very brackish. This is probably the most abundant species of nemertean on the Alaska coast, and is found nearer high-water mark and in more brackish water than almost any other species.

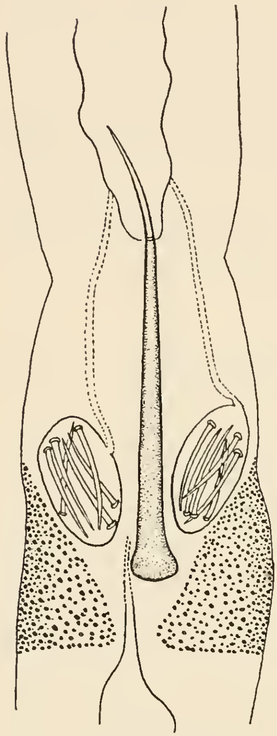

FIG. 32.— *Emplectonema gracile.* Stylet apparatus of proboscis.

Stimpson ('**57**) records it from San Francisco, and Griffin ('**98**, p. 207) found it at West Berkeley, California, Port Townsend, Wash., and Alaska, but considered it distinct from *E. gracile.* In the National Museum is a portion of a large individual from San Francisco, and nearly 40 specimens of small size collected by Dr. Dall at Unalaska Island. After having been in alcohol for many years these specimens still show their characteristic form and coloring.

The species is very common at Pacific Grove, California, where it occurs near the Hopkins Laboratory among mussels on large rocks fully exposed to the surf. Its known range on the Pacific coast is, therefore, from Monterey Bay, California, along the coast of British Columbia and the whole Pacific coast of Alaska to the Aleutian Islands.

It has also been recorded from the coasts of England, from the northern shores of Germany and France, from the Mediterranean coasts, and from Madeira. The most widely distant of these localities are separated by about half the circumference of the globe, but the form has not yet been found anywhere on the east coast of America. Isler (:**01**) records the species from Chile.

42. Emplectonema bürgeri Coe.

Proc. Wash. Acad. Sci., **3**, p. 25, Pl. 2, figs. 1, 2; Pl. 8, fig. 1; Pl. 12, fig. 3, 1901; Harriman Alaska Expedition, **11**, p. 25, 1903.

Emplectonema violaceum Griffin, Ann. N. Y. Acad. Sci., **11**, p. 209, 1898. Not *E. violaceum* Bürger.
E. bürgeri Coe, Harriman Alaska Expedition, **11**, p. 115, 1904.

Pl. **24**, figs. 187, 188; Text-fig. 33.

These worms are long, flat and ribbon-like, nearly as thick near the lateral margins as in the median line. The color shows considerable individual variation, but most specimens are dark, velvety brown above and flesh colored or creamy white below. Some are mottled, reddish brown or purple on the dorsal surface. Sometimes the head is almost without color. Ocelli very numerous, commonly numbering 60 or more on each side (Pl. **24**, fig. 187). The worms often attain the length of a meter, and are about 5 mm. in width.

The proboscis sheath reaches well toward the middle of the body, although the slender proboscis is but a fraction of this length. The armature of the proboscis includes a weak central stylet, the basis of which is swollen into a bulb posteriorly (Pl. **24**, fig. 188; Text-fig. 33) and of a pair of pouches, each usually containing three small accessory stylets. There are 11 proboscidial nerves. Cerebral sense organs remarkably large; situated slightly in front of brain. Narrow intestinal caeca extend forward well toward brain. Submuscu-

FIG. 33.—*Emplectonema bürgeri.* Outline of stylet apparatus.

lar glands enormously developed, extending posteriorly to anterior end of intestinal region.

Habitat.— Glacier Bay, Alaska; found under mussels on rocks between tides. The worms are gregarious in their habits, and several individuals were found knotted together in a seemingly inextricable mass, and were imbedded in a vast amount of slime (Coe, :01); Port Townsend, Washington (Griffin, '98). The present known range of the species is therefore only from Puget Sound to southern Alaska.

43. Emplectonema purpuratum, sp. nov.

Pl. 17, figs. 107, 108; Pl. 22, figs. 159, 160.

Body long, much flattened dorso-ventrally, and ribbon-like throughout; head rather narrow; posterior extremity slender.

Length 25 cm. or more; width about 3 mm.

Color.— Original coloring and markings are apparently well retained after preservation, although there are no notes as to color in life. Dorsal surface purplish or purplish brown from closely placed mottlings of pigment; ventral surface gray or yellowish. Body is paler anteriorly; tip and sides of snout lack the brownish mottlings and are of same color as ventral surface. The purplish brown mottlings are strictly confined to dorsal surface and are so thickly placed as to give a homogeneous color when seen without a lens. From the dorsal side there is no indication of the light color of ventral surface.

Ocelli.—Numerous ocelli lie on each side of head and extend forward to tip of snout, but their arrangement is difficult to determine owing to dark pigment of body. They are of larger size than in most species of genus.

Proboscis.— In one specimen there were three pouches of accessory stylets, and in another two. Each had two stylets with sometimes an immature third. The stylets are without the swollen heads so characteristic of *E. bürgeri*, but are especially remarkable in being fluted longitudinally (Pl. 17, figs. 107, 108; Pl. 22, figs. 159, 160). This peculiarity is conspicuous both in the central stylet and in the mature accessory stylets.

Basis of central stylet not swollen posteriorly as in *E. bürgeri*,

and is but a little wider posteriorly than near attachment of stylet (fig. 107). Length of basis in two individuals 0.15 mm. and 0.165 mm. Stylets are sharp and acutely pointed, but are rather broad at the base (fig. 108). They are a trifle shorter than the basis. The proboscis is provided with 16 nerves.

Cephalic glands are voluminous, filling up a large portion of the tissues of the snout. Submuscular glands well developed and of large size. They extend back through esophageal region, where they are situated mainly ventral to lateral margins of body, and extend inward practically through the whole layer of longitudinal muscles to the connective tissue about the lateral nerves and blood vessels.

Alimentary canal.— A pair of very narrow diverticula of the intestinal caecum extend forward well toward brain region. They lie above lateral borders of esophagus. A considerable distance posteriorly they become united into the broad, unpaired caecum which lies beneath the esophagus, as in *E. bürgeri*.

Blood and nephridial systems.— The blood vessels of the head are peculiar in that they do not appear as thin-walled lacunae, but always show distinct fibrous walls, and exhibit in a striking manner the epithelial cells with which the vessels are lined. Their arrangement is as in related species.

Nephridial tubules are voluminous and are limited to a short distance immediately behind brain.

Cerebral sense organs are, as in *E. bürgeri*, remarkably large for genus. They are much elongated and extend from a point well towards the tip of snout back nearly to brain region.

Habitat.— Adakh Island (Aleutian group), Alaska, two complete specimens fully 25 cm. in length. Collected by the Albatross, July 2, 1893.

In general appearance, shape of body, color, and in many points of internal anatomy, the species resembles *E. bürgeri* from southern Alaska and Puget Sound. In other anatomical features, and notably in armature of proboscis and in number of proboscis nerves, the two species differ widely. *E. bürgeri* has both stylets and basis of central stylet much swollen and has only 11 proboscidial nerves, while the present species has fluted stylets, not swollen at base, basis of stylet is not swollen posteriorly, and there are 16 proboscidial nerves.

With *E.* (*Eunemertes*) *violaceum* Bürger ('**96**) from Chile, there are many points of resemblance, but the presence of large cephalic glands and of comparatively large cerebral sense organs, which lie only a short distance in front of brain, will serve to distinguish the present species. The proboscis of *E. violaceum* has not been described.

Zygonemertes Montgomery.

Zool. Jahrb., Abth. Syst., **10**, p. 2, 1897.

Among the nemerteans of the Pacific coast are two species of which one is identical with the green *Amphiporus virescens* Verrill and the other resembles this species closely. A third form is closely related anatomically, but is white in color. These three species belong to the genus ZYGONEMERTES which Montgomery ('**97**[a], p. 2) has established for *A. virescens*. The members of this genus are closely similar anatomically to those of AMPHIPORUS but may be distinguished by the following peculiarities: —

Body long and slender, but not so elongated as in EMPLECTONEMA; head broader than neck in life, provided with two pairs of lateral oblique furrows; ocelli small and very numerous, extending posteriorly far beyond brain and above the lateral nerve cords; proboscis sheath extends to posterior end of body, while proboscis is comparatively short; armature of proboscis much as in AMPHIPORUS, although basis of central stylet is massive and has a concave or truncated posterior end, while stylet itself is comparatively weak; usually 10, 11, or 12 proboscidial nerves.

The worms are peculiar in life because of their long, very contractile bodies and broad heads, and are especially remarkable because of their extremely active habits, being very restless in confinement and in almost constant motion, often crawling out of the water and up the sides of the vessel in which they are contained.

44. Zygonemertes thalassina Coe.

Proc. Wash. Acad. Sci., **3**, p. 29, Pl. 2, fig. 5; Pl. 7, fig. 1; Pl. 13, fig. 2, 1901; Harriman Alaska Expedition, **11**, p. 29, 1904.

Text-figs. 17, 34, 35.

The very active and restless worms belonging to this species and the closely related *Z. virescens* may be easily recognized by their olive green color, and by the ocelli which are very numerous on each side of the head, and which extend posteriorly along the lateral nerve cords far behind the brain.

Mature individuals are very slender, and are usually from 30–60 mm. in length.

The proboscis sheath reaches to the posterior end of the body, but the proboscis itself is but little more than half as long. The central stylet of the proboscis is remarkably short and blunt; its basis is at least twice and often three times as long as the stylet itself, and is massive in proportions (Text-fig. 34). The basis is sharply truncated posteriorly, with serrated edges. Each of the two lateral pouches usually contains five remarkably stubby accessory stylets (Text-fig. 35). There are 12 proboscidial nerves. In *Z. virescens* the stylets are more slender, commonly but 2 or 3 in each lateral pouch, and the proboscis has but 10 or 11 nerves.

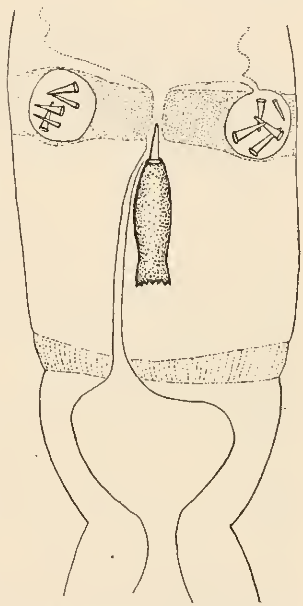

Fig. 34.—*Zygonemertes thalassina.* Outline of stylet apparatus of proboscis.

Habitat.—This species has been found only at Sitka, Alaska, where it is not uncommon among hydroids, broken shells, etc., in clear water (Coe, :**01**).

The only decided differences that I have been able to determine between this species and the closely related *Z. virescens* of the Cali-

fornia coast are in the number of proboscidial nerves and the character of the armature of proboscis (see p. 215). It is possible that collections in intermediate localities, as Puget Sound, will bring to light forms which show an intergradation between these two supposed species, thus uniting them into a single species showing considerable variation in structure of proboscis.

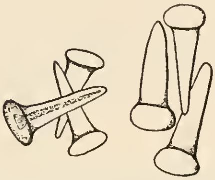

FIG. 35.—*Zygonemertes thalassina.* Accessory stylets.

45. **Zygonemertes virescens** (Verrill) Montgomery.

Amphiporus virescens Verrill, Proc. U. S. Nat. Mus., **2**, p. 183, 1879; Trans. Conn. Acad., **8**, p. 400, Pl. 33, figs. 4–4*e*, 1892.
Zygonemertes virescens Montgomery, Zool. Jahrb., Syst., **10**, p. 2, 1897.

Pl. **22**, figs. 141–144.

This common New England species occurs in considerable numbers on the piles of wharves in the harbors of Monterey, San Pedro, and San Diego, California.

It may be recognized by the following characters: — Body slender, rather depressed, head variable in shape, often wider than parts immediately following, provided with two pairs of oblique furrows as usual; anterior pair of furrows situated about half-way between brain and tip of snout when moderately extended, conspicuous on lateral margins when head is somewhat compressed.

Size. — The individuals collected in California were all of small size, although sexually mature. They measured only from 5 to 20 mm. in length, and were usually from 0.5 to 1 mm. wide. On the coast of New England the same species may become 40 mm. long, although the usual size is 25 mm. or less.

Color. — Usual color pale green, although some individuals, especially when immature, are flesh colored anteriorly, becoming pale green towards intestinal region, while others are yellowish green or pale olive green throughout. A few of the smaller individuals found at Monterey were cream colored in life, but assumed a greenish tinge after preservation. When examined with the microscope, numerous yellowish sickle-shaped bodies are seen to lie

in the outer integument, and in addition there are numerous radiating bluish green pigment granules in the same layer, but situated very superficially. Intestinal canal sometimes pale orange; mature ova greenish. Some individuals are yellow rather than green on ventral surface, although both surfaces are usually of about the same color. Greenish tinge retained for a long time after preservation, or reappears after such specimens are placed in clearing oil.

Ocelli. — Head provided with numerous ocelli, which extend posteriorly far beyond the brain. There are commonly 20 to 60 rather small ocelli on each side of head, arranged in two parallel, but very irregular, clusters (Pl. **22**, fig. 141) on each side, and extending back as far as the brain. Behind brain are usually 4 to 12 smaller ocelli situated at irregular intervals in a single row along lateral nerve cords. The brain is situated about half-way between tip of snout and most posterior ocellus.

Proboscis.—Sheath extends to posterior end of body, although proboscis is little more than half as long. Armature consists of short central stylet with large, cylindrical basis about 1½ times as long as stylet itself (Pl. **22**, figs. 142, 144). Stylets are not acutely pointed, nor are they as stubby as in *Z. thalassina.* Basis is somewhat narrowed near posterior end, which is commonly notched or longitudinally grooved (Pl. **22**, fig. 142). Length of basis commonly 0.12 to 0.16 mm., width about one third as great; length of stylet 0.08 to 0.1 mm. There is a much greater range of variation, however, than these figures indicate. The two lateral pouches usually contain 2 or 3 stylets each (Pl. **22**, fig. 143). Wreath of gland cells about stylet region of proboscis and basis of central stylet sometimes bluish green after preservation. There were 11 proboscidial nerves in each of five specimens sectioned, although one other individual had but 10. In New England specimens 10 is the usual number.

Internal anatomy.[1] — Cerebral sense organs large, situated immediately in front of brain. Intestinal caeca extend to posterior border of dorsal brain lobes. Nephridia situated in brain region and immediately posterior thereto; a single pair of efferent ducts open on latero-ventral surfaces of body immediately behind the brain or in the posterior brain region.

A terminal sense organ is situated directly above the rhynchodaeal opening.

[1] For further details, see Montgomery, '**97**, p. 2.

Habitat. — Common on piles of wharves at Monterey Bay, San Pedro, and San Diego, California. Common also on the coast of New England.

The worms belonging to this species are exceedingly active and restless, as described by Verrill ('**92**). Sexual products were found to be nearly mature in August, in California. Mature ova are greenish in color.

A single specimen, 25 mm. in length and 2½ mm. wide, which agrees with the above in all essential anatomical structures, was dredged off Coronado Beach, California, in 10 fms. Color after preservation dark grayish brown, but after being cleared in cedar oil assumed a purplish color with a tinge of green. Ocelli, internal structure, and proboscis armature are as in that species, and the proboscis is provided with 10 nerves only as in many of the individuals from New England.

The closely related species found in Alaska (*Z. thalassina*) differs from the above in number of nerves of proboscis and character of its armature, as stated on p. 213.

46. Zygonemertes albida Coe.

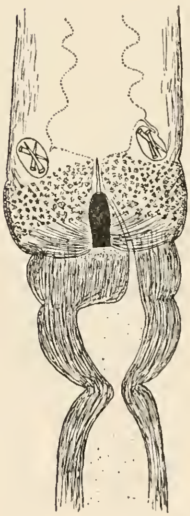

FIG. 36. — *Zygonemertes albida.* Stylet apparatus of proboscis.

Proc. Wash. Acad. Sci., **3**, p. 31, Pl. 3, fig. 2; Pl. 8, fig. 5, 1901; Harriman Alaska Expedition, **11**, p. 31, 1904.

Pl. **24**, figs. 182, 183; Text-fig. 36.

This is a small, moderately slender species, very active in habits. Sexually mature individuals were not more than 25 mm. in length. The color of these minute worms is white, with a tinge of yellow both above and below. Ocelli very numerous, being scattered irregularly on the head in front of the brain and extending backward as a single row on each side along the lateral nerves for about two fifths the length of the esophageal region (Pl. **24**, fig. 182). Central stylet of proboscis rather slender, basis elongated, sharply truncated posteriorly (Text-fig. 36, Pl. **24**, fig.

183). Eggs large; mature in June. Cerebral sense organs large, situated immediately in front of brain.

Habitat.—The species is known only from Victoria, B. C., where it was found on piles of a wharf associated with *A. imparispinosus*, which it somewhat resembles (Coe, :01).

The few individuals of this species which have been collected resemble immature and pale colored specimens of *Z. virescens*, but the present species remains whitish when sexually mature, possesses fewer ocelli and differs somewhat in armature of proboscis.

Nemertopsis Bürger.

Fauna und Flora des Golfes von Neapel, Monogr. **22**, p. 548, 1895.

Representatives of this genus are characterized by extremely long, thread-like bodies of firm consistency. They resemble Emplectonema in form, habits, and general internal anatomy, but differ in having only four ocelli, which are symmetrically placed on the head, in armature of proboscis, and in other anatomical details.

The worms are quite as slender as those of the genus Cephalothrix, but they do not coil the body in a spiral.

Proboscis sheath very short, proboscis armed with well developed central stylet and basis, and with two pouches of accessory stylets; cerebral sense organs small, situated well in front of brain. Cephalic glands usually well developed.

But three species of this genus have thus far been described. Of these, one occurs on the Pacific coast of North America, and the other two in the Mediterranean.

47. Nemertopsis gracilis Coe.

Harriman Alaska Expedition, **11**, p. 142, Pl. 15, fig. 1; Pl. 20, figs. 10, 11, 1904.

Pl. **11**, figs. 73, 74.

This is a very slender species bearing a close resemblance in form and color to *N. peronea* (Quatr.) Bürger, but differing somewhat in internal organization, especially in structure of proboscis armature and position of anterior end of intestinal caecum.

Body extremely long and filiform, being more slender than in any other species of nemertean found on the coast except Cephalothrix. Body commonly 10 to 15 cm. or more in length, and usually less than 1 mm. in breadth; head slightly broader than body, which is somewhat flattened dorso-ventrally, but of nearly equal width throughout its length.

Color.— Dorsal surface dull whitish with a tinge of brown, or sometimes decidedly brownish, with two narrow longitudinal bands of deep brown extending throughout the length of the body. Each of these brown bands is perhaps one eighth as broad as the body. They lie near the median dorsal line, and are separated from each other by about twice the width of either band. On the head they lie just internal to the eyes, and do not extend quite to the tip of snout (Pl. **11**, fig. 73). They are sharply marked off from the much paler color between them, but show a tendency to shade off laterally into the general pale brownish color of the dorsal surface. Toward the lateral margins the brownish color becomes very pale and gradually shades off into the whitish, grayish, or pale flesh color which characterizes the ventral surface.

Ocelli.— Four eyes of large size are arranged to form the corners of a square (Pl. **11**, fig. 73).

Cephalic glands.— Enormously developed cephalic glands occupy the greater portion of the head and stretch far back into body, extending even as far back as the most anterior sexual pouches. In the esophageal region these glands often occupy more space than the proboscis sheath and esophagus together, and fill up the space usually taken by the body parenchyma, which in this species is very much reduced.

Proboscis.— Proboscis sheath not much more than one third as long as body; proboscis provided with eight large nerves which reach back to the stylet apparatus; the muscular and epithelial layers are as in Amphiporus. Central stylet of proboscis slender, provided with an elongated, slender basis, measuring about 0.12 mm. in length by 0.02 mm. in average diameter. Basis is peculiar in being of nearly the same diameter throughout, and not swollen posteriorly (Pl. **11**, fig. 74). Shape of basis alone will readily serve to distinguish the present species from *N. peronea*, which has a short, conical basis. Each of the two lateral pouches usually contains from four to six slender stylets. In the specimens preserved

in formalin there is no evidence that any of the stylets have their heads lobed or five-parted as do those of *N. peronea*.

Alimentary canal.— The intestinal caecum, which lies in the median line directly beneath the pylorus, is very short and without branches; it is much shorter than in *N. peronea*, and is separated from the brain by several times its length, while in *N. peronea* it is described by Bürger ('**95**, p. 549) as reaching nearly to the brain.

Nervous system and sense organs.— Brain and nervous system present no marked deviations from those of *N. peronea*. Cerebral sense organs small, much elongated, situated far in front of brain, and connected with exterior on antero-lateral borders of snout (Pl. **11**, fig. 73).

Habitat.— Pacific Grove, California, among mussels and other growths on rocks at low water; not common. Sexual products are mature in August and September. Collected in same locality in 1899, by C. B. Wilson.

Paranemertes Coe.

Proc. Wash. Acad. Sci., **3**, p. 32, 1901.

Body of large size, rather stout, usually much rounded in the esophageal region but flattened posteriorly. Head not marked off from body, of variable form, in some states of contraction often emarginate in front. There is commonly a pair of inconspicuous oblique furrows back of head. Nerve cords and blood vessels join on dorsal side of posterior end of intestine.

Mouth opens into rhynchodaeum. Proboscis sheath commonly reaches but little beyond middle of body — in *P. peregrina* to three fourths the distance towards posterior extremity. Proboscis small (*P. pallida*), of medium size (*P. peregrina*), or large (*P. carnea*). There is a single central stylet in proboscis, and usually four or more pouches of accessory stylets. Some individuals of *P. peregrina*, however, have but two. Ocelli numerous and minute in the three species mentioned, while in the fourth species (*P. californica*) they are represented by only 2 pigment spots (sometimes fragmented) on tip of snout. Cerebral sense organs rather small, situated in front of brain. Submuscular glands usually well developed in esophageal region of body.

The species of this genus show considerable resemblance to those of EMPLECTONEMA Stimpson. They differ, however, in general shape and appearance of body, never being very long or slender, and individuals do not coil their bodies into a mass as those of EMPLECTONEMA are so prone to do. The proboscis is much larger and the central stylet is always well developed. The proboscis sheath is also much longer. In many respects the genus resembles AMPHIPORUS. The body is much longer, however, and not nearly so contractile, the proboscis is not nearly so large, and the proboscis sheath is not so long. The armature of the proboscis resembles that in some species of AMPHIPORUS.

PARANEMERTES is known only from the Pacific coast of North America, where it is represented by at least four species, none of which have been recorded from other parts of the world.

48. Paranemertes peregrina Coe.

Proc. Wash. Acad. Sci., **3**, p. 33, Pl. 2, fig. 6; Pl. 3, fig. 5, 1901; Harriman Alaska Expedition, **11**, p. 33, 1904.

Pl. **1**, figs. 7–9; Pl. **16**, figs. 95, 96; Pl. **17**, fig. 103; Pl. **24**, fig. 192; Pl. **25**, figs. 198, 199; Text-figs. 37, 38.

This is one of the commonest and most widely distributed species of nemertean found on the Pacific coast.

The worms may be recognized by the rather slender body of a purplish brown, dark brown or orange brown color above, on the sides, and on the margins of the ventral surface, while the median third, or a little more, of the ventral surface is white, yellowish white or deep yellow (Pl. **1**, figs. 7–9). There is a narrow, but conspicuous V-shaped white marking just back of the head. This is placed symmetrically on the dorsal surface with the angle directed backward. There is also a pair of yellowish spots, continuous with the color of ventral surface, on each lateral margin in front of brain.

The head is usually broader than the parts following, and is commonly sharply truncated. A pair of delicate, whitish, transverse grooves lie on the lateral margins of the head (Pl. **1**, figs. 7, 8).

There are two, and sometimes four, pouches of accessory stylets,[1] with six to ten stylets in each pouch (Text-fig. 37). The proboscis has fourteen nerves.

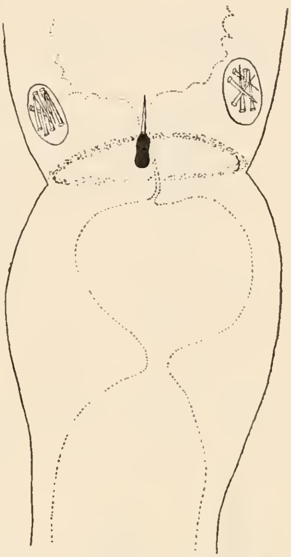

FIG. 37.—*Paranemertes peregrina*. Outline of stylet apparatus of proboscis.

In addition to the anatomical peculiarities described in the paper mentioned above (Coe, :**01**, p. 33) the following data from a study of the species in California may be noted:

Color.—In California many individuals have the ventral surface deep yellow anteriorly and olive in intestinal region; or the ventral surface may be orange yellow anteriorly and grayish posteriorly.

Ocelli.—Two groups of ocelli are situated on each side of head; of these the anterior, marginal group contains from 5 to 12 rather large ocelli in a single irregular row, while about the same number of smaller ocelli are situated more posteriorly, near the brain lobes, and are arranged in an irregular cluster (Pl. **16**, fig. 95; Pl. **17**, fig. 103; Pl. **25**, figs. 198, 199). A minute and evidently very young specimen, but 10 mm. in length, had but 4 ocelli in each of the four groups.

In all specimens collected in California the stylets of the proboscis are very peculiar in that they exhibit an appearance as if braided or woven together out of several parts. The optical effect produced (Pl. **16**, fig. 96; Pl. **24**, fig. 192; Text-fig. 38) is probably the result of flutings which ascend spirally toward the tip of stylet, the translucency of which allows the flutings of both the lower and upper surface to appear to lie in the same plane. The effect, however, is exactly that of a braided structure tapering to a sharp point and composed of at least four strands. It is also possible that the braided appearance is produced by superficial markings. Both cen-

[1] On the coast of California two pouches only seemed to be the almost constant number, while there were commonly four in Alaska specimens.

tral and accessory stylets exhibit the same braided appearance, and are of the same size and shape when mature.

Variations in size of central stylet and its basis in several individuals are given below:

Length of central stylet	Length and width of basis	Number of stylets in lateral pouches
.045 mm.	.045 mm. × .021 mm.	3 — 3
.063	.048 × .023	3 — 3
.081	.072 × .033	2 — 3
.081	.075 × .033	3 — 2
.084	.084 × .039	3 — 3
.087	.078 × .036	2 — 2
.090	.078 × .036	4 — 4
.090	.078 × .042	2 — 3

The specimen with the smallest stylet apparatus included above measured but 1 cm. in length, while several with the largest stylets were 15 to 20 cm. long. As a general rule the larger individuals have the larger stylet and basis, but the correlation in size is not very exact, and is subject to many exceptions. The basis averages a trifle shorter than the stylet itself, and the largest stylet measured is just twice the length of the smallest.

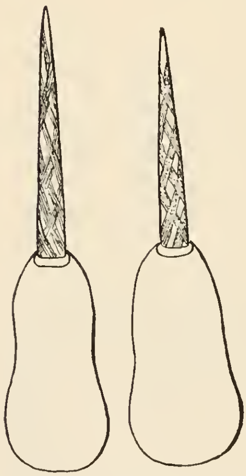

Fig. 38.— *Paranemertes peregrina.* Outlines of central stylets and bases, showing peculiar spirally grooved appearance of stylet.

All the Californian specimens examined, whether from Monterey Bay or San Pedro, differ therefore from most individuals collected in Alaska in the number of lateral stylet pouches as well as in the number of accessory stylets. Four pouches are commonly found in Alaska specimens, but I have not yet seen any individual from California with more than two. In Alaska there are commonly 6 to 10 accessory stylets in each lateral pouch (Coe, : **01**, p. 34), while, as shown above, 2 to 4 is the rule in California. The largest individual which I examined in California, however, measured but 25 cm., while I have collected specimens in

Alaska fully 40 cm. in length. The evidence from these observations seems to indicate, therefore, that increase in size of individuals of this species is to some extent correlated with (*a*) increase in number of ocelli, (*b*) increase in size of basis and stylets, (*c*) increase in number of lateral pouches, and (*d*) increase in number of stylets in each pouch.

Additional notes by Professor Wilson on specimens collected at Pacific Grove, Cal., are as follows: — Body dark chocolate brown, with bluish tinge above and yellow beneath. Head well differentiated by color and by lateral constrictions during movement. An irregular row of 10 to 12 or more ocelli on each antero-lateral margin of head, and a posterior pair of clusters each with 7–12 or more ocelli near the brain. The posterior clusters are surrounded by the yellow color of ventral surface, which in this region encroaches on the brown color of dorsal surface, so that the brown color of head is connected with that of the body by a comparatively narrow band of brown color. Very common everywhere at Pacific Grove under rocks and among seaweeds. Length 6–11 cm.; width when extended 2 mm.

Habitat.— This is a very restless nemertean, and on cloudy days was frequently found crawling about on the beach between tides. It occurs from low tide well up toward high-water mark in every variety of situation — under stones, among seaweeds, barnacles, mussels, etc. The worms are remarkably tenacious of life, and will live under apparently most unfavorable conditions. They are voracious feeders and were often found with partially swallowed chaetopods.

In the collections at hand, specimens are represented from the following localities:

1. A number of specimens collected by Mr. Griffin at Port Townsend, Washington.

2. One specimen collected by Mr. Shearer at Albert's Head, Vancouver Island, B. C.

3. Several specimens from Sand Point, Humbolt Bay, Alaska, collected by the U. S. F. C. S. Albatross.

4. Unalaska Island. W. H. Dall.

5. Atka Island, Aleutian group. U. S. F. C. S. Albatross.

6. Adakh Island, Aleutian group. U. S. F. C. S. Albatross, July 2, 1893.

7. Bering Island, Commander group. Collected by L. Stejneger, 1882–1883.

8. Same locality and collector, May, 1882.

9. Copper Island, Commander group, May 6, 1882. L. Stejneger.

10. "Portage Bay, Alaska." There are at least four bays of this name in different portions of the territory, so that the locality is uncertain.

11. Crescent City, California. Collected by Mr. A. Agassiz, in 1860. A small specimen apparently belonging to this species was also collected by Mr. Agassiz at Mendocino, California.

12. San Pedro, California, among algae near low-water mark; 15 to 20 cm. in length; not common.

13. Pacific Grove and Monterey, California, among algae and in crevices of rocks between tides; 5 to 15 cm. in length; very abundant.

14. Collected by Prof. C. B. Wilson at Pacific Grove, California.

I have personally found the species abundant at various localities from San Pedro, California, to Unalaska Island. The localities recorded above show that the species ranges from San Pedro, California, along the coasts of British Columbia and Alaska, to the Aleutian Islands, and thence across to the Commander Islands near the coast of Kamchatka. Its present known range is therefore more than 4000 miles, and future collections will doubtless extend these limits.

The species is more abundant in the more northern localities and the individuals attain a much larger average size than those from California.

49. Paranemertes pallida Coe.

Proc. Washington Acad. Sci., **3**, p. 36, Pl. 7, fig. 3; Pl. 12, fig. 1, 1901; Harriman Alaska Expedition, **11**, p. 36, 1904.

Pl. **24**, figs. 190, 191; Text-fig. 39.

This is a rather large, stout, rounded species, opaque white in color. There are usually 30 or more minute ocelli on each side of the head (Pl. **24**, fig. 190). The proboscis is small, short, and remarkably slender. It is provided with 4 pouches of accessory sty-

lets usually with 2 stylets each (Pl. **24**, fig. 191; Text-fig. 39). There are 9 or 10 proboscidial nerves.

Both cephalic and submuscular glands well developed; cerebral sense organs of moderate size, situated in front of brain. Nephridia extend through almost entire esophageal region; a single pair of large efferent ducts are situated in their middle portions.

Intestinal caeca short and little developed, not extending nearly to brain.

Habitat.—The species is known only from Alaska, where it is recorded from Yakutat and from Sand Point on Popof Island (Coe, :**01**). The few specimens found were from 15–25 cm. in length, and were collected between tides under stones.

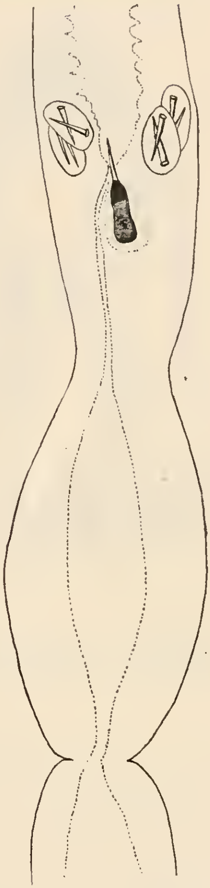

Fig. 39.—*Paranemertes pallida.* Outline of stylet apparatus of proboscis.

50. Paranemertes carnea Coe.

Proc. Wash. Acad. Sci., **3**, p. 37, Pl. 3, figs. 3, 4; Pl. 7, fig. 4; Pl. 8, fig. 7, 1901; Harriman Alaska Expedition, **11**, p. 37, 1904.

Pl. **23**, figs. 177, 178; Text-fig. 40.

This species has a very pale red or flesh-like color, and may be readily distinguished from other described forms by: (1) the rather stout body, rounded anteriorly, much flattened posteriorly; (2) head very variable in shape and may be pointed, rounded, or emarginate in front, according to state of contraction; (3) usually 20–32 ocelli on head arranged in four more or less distinct clusters (Pl. **23**, fig. 177); (4) central stylet of proboscis of the Amphiporus type, but the armature is peculiar in that there are usually six pouches of accessory stylets with usually two slender stylets each (Pl. **23**, fig. 178; Text-fig. 40); (5) proboscis has 11, 12 or 13 nerves.

Individuals may occasionally grow to a length of 50 cm., although most of the specimens collected were less than half this length.

Habitat. — This species is conspicuous because of its clear, rosy or flesh-like color, which is all the more striking in contrast with the black mud in which it is usually found. It occurs between tides in muddy locations over a large portion of the southern Alaska coast. It was collected at Taku Harbor, Sitka, Yakutat, Prince William Sound, and Popof Island on the Harriman Expedition, although only a few specimens were found at each locality.

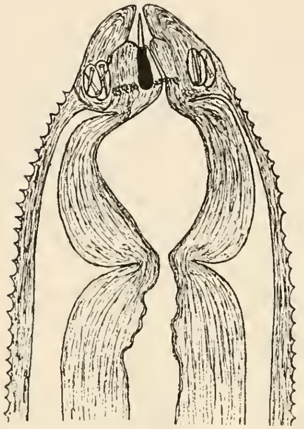

Fig. 40.—*Paranemertes carnea.* Extremity of everted proboscis, with six pouches of accessory stylets, of which four are shown.

A large individual collected by Mr. Shearer at Albert's Head, Vancouver Island, had 13 proboscidial nerves, and the proboscis was provided with six pouches of accessory stylets, containing four moderately slender stylets each.

51. Paranemertes californica Coe.

Harriman Alaska Expedition, **11**, p. 144, Pl. 15, fig. 2; Pl. 18, figs. 1–5; Pl. 21, figs. 1–9, 1904.

Pl. **11**, fig. 75; Text-figs. 6, 11, 41–43.

This species is at present known only from San Pedro and San Diego, California. The more striking peculiarities of external appearance and internal anatomy are given in the following paragraphs:

Body long, moderately slender, rounded or cylindrical in the short esophageal region, very much flattened farther back; head small and acutely pointed in ordinary states of contraction; with two pairs of oblique grooves uniting in mid-dorsal line; snout with the ocelli can be retracted to a very considerable extent into the tissues of the head. Intestinal region flat and ribbon-like with thin margins which are sometimes bent toward the ventral surface, often much wrinkled when the body is strongly contracted; posterior extremity rounded.

Size. — Length commonly from 10 to 20 cm., occasionally 45 cm.; width 4 to 6 mm.

Color. — Anterior portion of body rosy, pale orange inclining to flesh color, or sometimes more decidedly orange; head distinctly orange, but usually of a pale tint; brain region a little more reddish in color. General color of intestinal region grayish, flesh color or very pale salmon, and somewhat translucent; ground color much obscured by dark green color of intestinal tract, imparting decided greenish tinge to whole body back of esophageal region. Green color of intestinal lobes and intestinal caecum separated on dorsal surface, except far posteriorly, by reddish color of rhynchocoel fluid.

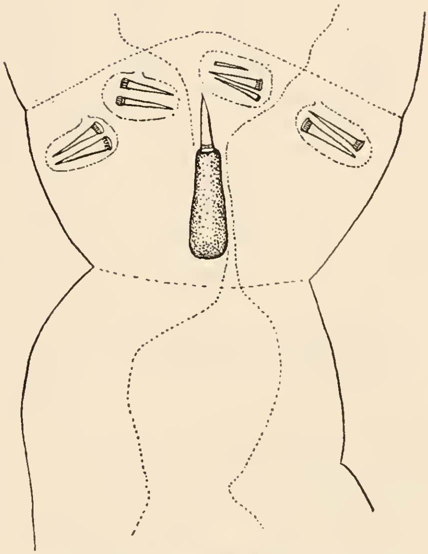

FIG. 41.—*Paranemertes californica.* Stylet apparatus of proboscis, showing central stylet and basis and four pouches of accessory stylets.

Ventral surface somewhat paler than dorsal, translucent; color much obscured by deep green of intestinal canal. Intestinal caeca green in color, stretching forward on each side of body well toward mouth. Green color very permanent, remaining conspicuous after preservation in formalin or in alcohol, and even after imbedding in paraffin.

Esophageal region almost colorless after preservation; remaining portions of body deep green from permanent color of intestinal tract.

Proboscis. — Proboscis sheath from one half to two thirds the length of body, provided anteriorly with remarkably powerful musculature. Rhynchocoel fluid deep red; corpuscles colorless. Proboscis fairly large, provided with central stylet and either four or six pouches of accessory stylets (Text-figs. 11 and 41). Basis of central stylet rather slender, slightly narrower anteriorly, but of fairly

even diameter throughout (Pl. **11**, fig. 75; Text-figs. 41, 42); stylet moderately slender, about half as long as basis, or sometimes a little more than half as long. Usually two or three accessory stylets in each of the four or six pouches, all of which, as well as the central stylet, show a peculiar darker or more opaque portion about the head (Pl. **11**, fig. 75; Text-fig. 43).

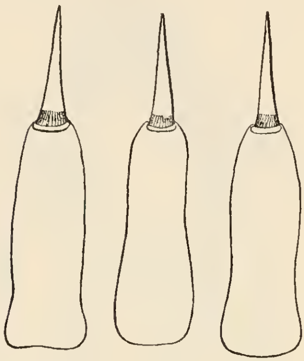

Fig. 42. — *Paranemerles californica.* Central stylets and bases from three individuals, showing variation in size and shape.

Length of basis about 0.36 mm.; average width 0.1 mm.; length of stylets 0.17–0.2 mm. Usually 10 proboscidial nerves, occasionally 11 or 12.

Ocelli. — Two very small ocelli, occasionally fragmented into two groups of minute granules, are situated near the tip of snout. They lie deep in the tissues of the head and are difficult to see in the living worm, being usually distinguished readily only after the specimen has been cleared in some suitable medium.

Cerebral sense organs extremely small, measuring scarcely more than one tenth the diameter of head in same region; situated well in front of brain, and connected with exterior on latero-ventral margins of head near tip of snout.

Cephalic glands voluminous, composing the greater portion of the tissues of head in front of brain, and being interspersed with connective tissue and muscle fibers.

Submuscular glands sparsely scattered in esophageal region.

Fig. 43. — *Paranemerles californica.* Accessory stylets, highly magnified, showing the peculiar striated basal portion of each.

Muscular system. — A peculiar secondary longitudinal muscular layer arises in the head quite independently of main longitudinal muscles; it increases greatly in size back of brain, but remains separated from the musculature of the body walls by a thick layer of parenchyma. Back of brain this secondary muscular layer (Text-fig. 6) becomes thicker than longitudinal layer of body walls, and its fibers

are larger, more closely placed in their bundles and stain more deeply. In esophageal region these muscles become arranged just internal to the longitudinal muscles of body walls and form a portion of this layer. In no other species has any such condition been described, though an approach to it is met with in *A. nebulosus* (Coe, :01, p. 49), where the submuscular glands develop to such an extent as to form a distinct layer which divides the longitudinal muscular layer into an outer and an inner portion. In *A. gelatinosus* also, as described on p. 260, a few longitudinal muscles lie above the proboscis sheath in the brain region, but these connect almost directly with the proboscis sheath and body muscles, and do not extend for any considerable distance either anteriorly or posteriorly.

Alimentary canal. — The pylorus is remarkably short, being only about twice as long as the distance from tip of snout to brain. It then enters the dorsal wall of the intestinal canal, which in this case corresponds in position and histological structure to the intestinal caecum of other forms, although it does not end blindly and in this case must be called the anterior chamber of the intestine. An extremely short caecum proper is, however, present and extends forward with a few pairs of lateral lobes for a very short distance anterior to the posterior opening of the pylorus. This condition has evidently arisen from the disappearing of the long, slender pylorus of the typical Hoplonemertean, so that the pylorus opens very near the anterior end of the long caecum instead of far back as in most other members of the order. Both this anterior intestinal chamber and the caecum proper have the same anatomical and histological peculiarities. Both send off paired lateral diverticula, which are closely placed together, of rather small size, extending laterally somewhat above the lateral nerves, and provided with the deep green pigment mentioned above. Toward the posterior end of the anterior chamber the diverticula become longer and the canal gradually takes on the character of the intestine proper near the most anterior sexual glands.

Blood and nephridial systems. — The blood vessels of head and esophageal region are all of small size, and extend on all sides above proboscis sheath and beneath esophagus, as well as laterally. Back toward the intestinal region they form the usual pair of lateral vessels.

Efferent nephridial ducts were not found, nor were there any

large nephridial canals found near the blood vessels as in related species. Very fine canals, however, which very likely belong to the nephridial system, are scattered loosely in the parenchyma. It seems probable, therefore, that the nephridia are diffused, as in STICHOSTEMMA.

Habitat. — Individuals of this species are rather common in sand at low water at San Diego and San Pedro, California. Occasionally found on piles of wharves. The worms exude an abundance of a milky mucus when handled, and are very peculiar because of their translucency and the deep green pigment of their intestinal canals.

Carcinonemertes Coe.

Amer. Nat., **36**, p. 440, 1902.

Parasitic nemerteans living on various species of crabs and sometimes other Crustacea. Body small, slender, filiform, rounded, and of about the same diameter throughout; head without distinct lateral grooves. Body not coiled or twisted, but often folded sharply so that anterior portion of body lies parallel and in contact with posterior portion. Mouth and proboscis open together; esophagus extremely short, opening broadly into intestine through a large muscular chamber (stomach) situated immediately behind brain; intestine broad, with short lateral pouches which are but little developed in posterior portion of body; pylorus and intestinal caecum practically wanting.

Proboscis sheath without muscular walls, consisting merely of a thin membrane closely applied to the small proboscis. Proboscis but little developed, very small in size, and extremely short, without lateral pouches of reserve stylets, but armed with minute central stylet and basis only. Stylet region of proboscis can be withdrawn but little behind brain; consequently anterior chamber is very short, without distinct muscular layers, without distinct nerves, and without a thickened glandular epithelium such as occurs in almost all other nemerteans. Chamber immediately behind stylet small but muscular, and with a lining of flattened epithelium, while posterior proboscidial cavity is very short, often almost spherical, highly glandular, connected closely with the rudiments of the proboscis sheath and imbedded in the connective tissue which lies internal to the body musculature.

Cephalic glands massively developed; a remarkable development of submuscular glands extends throughout whole length of body, usually forming a distinct layer internal to the muscular walls of body, and often thicker than all other layers of body wall combined. Cerebral sense organs probably wanting. Ocelli two; occasionally fragmented into four.

Usually oviparous, though fertilization often takes place internally, and sometimes a portion of the ova of an individual may be retained in the body until after the development of free-swimming embryos. Development without complicated metamorphosis.

52. Carcinonemertes epialti Coe.

Amer. Nat., **36**, p. 442, 1902.

Harriman Alaska Expedition, **11**, p. 151, Pl. **9**, figs. 1–9, 1904.

Pl. **2**, fig. 20; Text-figs. 7–9, 16, 27, 28, 44, 45.

Body small, rounded, slender; sexually mature individuals about 4–6 mm. in length and less than 0.5 mm. in diameter; head not demarcated from body; lateral grooves and cerebral sense organs wanting.

Color. — Bright orange, sometimes inclining more to reddish and sometimes to yellowish (Pl. **2**, fig. 20). Head a little paler, for the color is largely due to the intestinal lobes which extend forward to brain.

Ocelli. — A pair of ocelli of irregular outline, but sometimes crescent shaped, lie about midway between tip of snout and brain (Pl. **2**, fig. 20; Text-fig. 44).

Proboscis. — Proboscis sheath consists merely of few fibers of connective tissue supporting a very thin, flattened epithelium, and can be seen only in favorable preparations. Proboscis very minute and short, extending scarcely more than its own diameter posterior to brain (Text-fig. 9). Anterior chamber of proboscis very small, not as long as diameter of a brain lobe, lined with thin, scarcely glandular, epithelium (Text-fig. 7). Stylet region swollen with large gland cells. Central stylet minute; basis about four times as long as broad, but very small, measuring only about .027–.033 mm.

in length and .005–.008 mm. in diameter (Text-fig. 45). Accessory stylets wanting. Posterior chamber oval, with small lumen and very massive glandular walls lined with high columnar cells irregularly arranged in several layers (Text-figs. 7, 8, 9, 16). Posterior chamber usually bent sharply toward dorsal side of body, and closely imbedded in surrounding connective tissue (Text-figs. 8, 16).

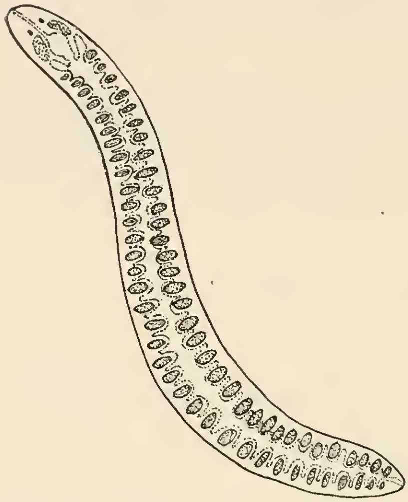

FIG. 44 — *Carcinonemertes epialti*. Diagram of body, showing ocelli, brain lobes, alimentary canal (in dotted lines) and genital glands.

Cephalic glands extremely voluminous, making up a great part of the tissues of head (Text-fig. 9). Back of brain they pass gradually into *submuscular glands* which extend as a very thick layer throughout entire body (Text-figs. 16, 27, 28). The secretions of these glands furnish the sticky mucus by means of which the worms cling so tenaciously to the crab or to other objects.

Alimentary canal.— Esophagus leaves rhynchodaeum just in front of brain and passes beneath ventral commissure as a narrow tube lined with rather flat cells, as in other genera. Just back of brain, however, it becomes enormously enlarged with high, columnar, ciliated epithelium, richly provided with gland cells (Text-fig. 16). This portion, the stomach, is highly muscular and somewhat barrel-shaped, projecting a little way backward into the broad intestine which immediately follows posteriorly. This muscular stomach (Text-fig. 16, *e*) is closely connected with the proboscis by strong connective tissue fibers, and the

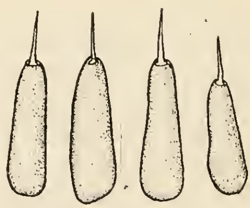

FIG. 45. — *Carcinonemertes epialti*. Several stylets, with their bases showing variations in form and size.

movements of both organs are interdependent, so that when stylet is everted to pierce the tissues of the host, the stomach is opened widely to suck up the exuding fluids.

Reproductive organs.— Sexually mature in September. Genital pouches extend much farther forward than in almost any other nemertean, reaching very nearly to brain (Text-fig. 44). Ovaries regularly paired, with a single large pouch containing usually from ten to thirty ova between each pair of intestinal lobes (Text-fig. 27). Spermaries far more numerous, surrounding intestinal canal on all sides; as many as fifteen or more being sometimes found in a single transverse section (Text fig. 28). As in most parasitic animals the abundance of sexual products is greatly in excess of that in related non-parasitic forms.

Habitat.— This species lives when sexually mature among the egg masses of *Epialtus productus*, the common kelp crab of the California coast. Upward of one hundred of these little worms were found among the eggs of a single crab at Monterey, California, in 1901. I was unable to determine whether the worms pass their early life on the gills of the crab, as does *C. carcinophila* of the Atlantic coast and Europe, but suspect that this may be the case.

Amphiporus Ehrenberg.

Symbolae Physicae, Berlin, 1831.

This is by far the most common genus on the Pacific coast of North America and to it belong 21 of the 86 species of nemerteans enumerated in this paper.

The genus Amphiporus includes mostly rather stout, solid, often flattened forms, usually of considerable size, which are capable of an almost incredible amount of extension and contraction. A few forms, however, are long and cylindrical, even when contracted, but others can contract until the body becomes almost barrel-shaped. The worms can neither swim nor roll up spirally.

Proboscis provided with a single, well developed central stylet, with a barrel-shaped or conical basis, and with two or more pouches of accessory stylets. Proboscis sheath usually reaches nearly or quite to posterior end of body; without lateral diverticula. Number of proboscis nerves ranges from 6 to more than

30 in different forms, but shows very little variation in the same species. Ocelli are usually present in very considerable numbers. A few forms are without eyes, and a few others have but a single pair — there are never four. The eyes do not extend far behind the brain. Cerebral sense organs are usually well developed. Their position is most commonly in front of the brain, but they are sometimes beside or even behind the ganglia. Neurochord cells absent. Submuscular glands often well developed; cephalic glands commonly much reduced.

The genus Amphiporus may be looked upon as the genus most characteristic of this region, including as it does nearly one fourth of the total number of species known at present from this locality. Upwards of 50 species of this genus have been described from other parts of the world, of which only 2 (*A. cruentatus* and *A. angulatus*) are as yet known from the Pacific coast.

An even larger proportion of the nemerteans of the Atlantic coast of North America belong to this same genus, however, for here 18 out of a total of 62 species have been referred to the genus Amphiporus, and on the northern coasts of Europe an abundance of species of this genus is encountered. As a rule, the species are of considerable size, and great numbers of individuals often occur in the same locality. In the cooler waters of the Southern Hemisphere also a considerable proportion of the nemerteans thus far described belong to this genus.

In the tropics, however, as remarked by Punnett (:01, p. 101), very few species of Amphiporus occur, so that a characteristic feature of collections from the Indian Ocean, Polynesia, and other tropical localities, is the great scarcity of representatives of this genus.

An examination of the anatomical peculiarities of the 21 species represented in the region covered by this report reveal certain interesting deviations from the average type from other quarters of the globe. Some of the more important of these characters, and especially those relied upon in classification, are here presented in tabular form in order that a comparison of all the species represented in regard to these particular characters may be facilitated. In the last column a single deviating character is mentioned for some of the species.

Amphiporus	General color	Ocelli	Character of basis	Relative length of stylet (S) to basis (B)	Number of pouches of reserve stylets	Number of proboscis nerves	Position of cerebral sense organ relative to brain	Other peculiarities
angulatus	brown or purple, pale beneath	40–70	conical	$S = B$	2 (4)	17–20	anterior	—
bimaculatus	brown or reddish	40–70	small	$S = 2\,B$	2 or 4	14–16	beside	Esophageal caecum
tigrinus	yellow or orange	20–40	massive	$S = \frac{1}{2}\,B$	2	—	anterior	Ova green
nebulosus	gray, dark blotches	30–50	bell-shaped	$S = B$	2	17	"	—
formidabilis	whitish	60–250	conical	$S = \frac{1}{5}\,B$	6–12	30±	"	Many nephridial ducts
imparispinosus	white	30–50	conical	$S = \frac{4}{5}\,B$	3	15(12?)	"	" " "
similis	white	12–24	slender	$S = \frac{7}{8}\,B$	2	10	"	—
paulinus	—	many	—	$S = B$	2	15	"	—
punctatulus	mottled	26–44	oval	$S = 2\frac{1}{4}\,B$	2	12 or 13	beside	Free-swimming
gelatinosus	—	30 +	—	—	—	—	minute, anterior	Gelatinous
californicus	red	8–16	conical	$S = B$	2	10–12	anterior	Ova green
macracanthus	—	—	massive, slender	$S = \frac{1}{3}\,B$	2	10	—	Basis 1 mm. in length
pacificus	reddish	20–40	conical	$S = B$	2	14	beside	—
occidentalis	brown mottlings	20 +	—	—	—	—	beside	Esophageal caecum
rubellus	pale red	20–40	—	—	—	14	beside	" "
flavescens	pale yellow	14–50	bell-shaped	$S = B$	2	10 or 11	large, anterior	Rhynchocoel corpuscles yellow
leptacanthus	whitish	30–40	very slender	—	2	—	minute, far anterior	—
fulvus	brown	ca. 50	bell-shaped	$S = 1\frac{1}{3}\,B$	2	—	large, anterior	—
cruentatus	yellowish	10–20	very slender	$S = B$	2	—	—	Blood corpuscles red
brunneus	dark brown; whitish beneath	—	long	—	2	—	anterior	—
drepanophoroides	red; white beneath	many	—	—	—	—	beside	Intestinal caecum absent

Color.— From the preceding table it is readily seen that 9 of the 21 species represented have a prevailing color of red or brownish on the dorsal surface, while 4 are whitish or very pale in color, 3 are yellowish or orange, 3 are conspicuously mottled, and in 3 species the color in life is unknown.

Ocelli.— The smallest number of ocelli found in any of these species when mature is 8, while in another form (*A. formidabilis*) as many as 250 ocelli may occur. The average number of the 17 species in which the ocelli have been carefully observed is approximately 40, a number agreeing fairly well with the average number found in both the New England and the European forms.

Stylet and basis.— In regard to the relative length of the central stylet and its basis, there are 7 species in which both stylet and basis are of approximately equal length, and three others in which the basis is but a little longer than the stylet. In a single form (*A. tigrinus*) the stylet is but half as long as the basis, and in another species (*A. macracanthus*), where the basis becomes fully a millimeter in length, the stylet is but one third as long. In one form (*A. fulvus*) the stylet is a third longer than basis, in another (*A. bimaculatus*) it is twice as long as basis, while in a third species (*A. punctatulus*) the stylet is two and one fourth times the length of basis. In 6 forms the armature of the proboscis is as yet but incompletely described or wholly unknown.

Accessory stylets.— In at least 13 of the 21 species the occurrence of more than two pouches of accessory stylets must be regarded as an abnormality; a single species (*A. angulatus*) has four occasionally, though usually but two, and while the Alaska specimens of *A. bimaculatus* have commonly four lateral pouches, those from the coast of California usually have but two. A single species (*A. imparispinosus*) has almost invariably three of these pouches, a number characteristic of only one other species in the world, so far as is known. One form (*A. formidabilis*) is provided with from six to twelve lateral pouches, the larger of these numbers being equalled in but a single other known species[1] from any part of the world, although one other species has seven and another eight.

Proboscidial nerves.— Of the 12 forms in which the number of proboscidial nerves is accurately known, the smallest number

[1] *A. spinosissimus* Bürger, from the island of South Georgia.

observed is 10, and this number occurs regularly in two species, while a third form has either 10 or 11, and a fourth 10, 11 or 12. One species has 12 or 13, two others 14, one 14 to 16, one 15, one 17, and the number in a single species varies from 17 to 20. These numbers accord well with those of the known species from other parts of the world.

Cerebral sense organs. — In regard to the relative position of the cerebral sense organs with regard to the brain, by far the greater number, or 13 out of the 19 species in which this relation is known, have the cerebral sense organs situated anterior to the brain. In several of these, this organ is small and situated well in front of the brain, while in others it is nearly as large as one of the ganglia, and lies close against the anterior border of the brain. In the other 6 species the sense organs are of very large size and are situated in the angle between dorsal and ventral ganglia, in some forms projecting well in front of the ganglia, and in others extending some little distance posterior to the brain. In all cases, however, the canal which communicates with the exterior passes anteriorly, and usually opens to the ventro-lateral surface of the head a short distance in front of the brain. In some of the species where the cerebral sense organs lie far in front of the brain, the canal opens to the surface but a very short distance behind the tip of the snout.

Other peculiarities. — Among the other anatomical peculiarities in which certain of these species differ from most other described forms of the genus, the presence of a highly developed esophageal caecum, extending backward beneath the esophagus proper and stomach and ending blindly posteriorly in three species (*A. occidentalis*, *A. rubellus*, and *A. bimaculatus*), has as yet been observed in but two other species of the genus.[1] The females of two other species are conspicuous when sexually mature because of their bright green ova; at least one species (*A. cruentatus*) has deep red blood corpuscles, and another (*A. flavescens*) has yellow proboscis sheath corpuscles. One form (*A. punctatulus*) is oval, flattened, and probably free-swimming; two (*A. imparispinosus* and *A. formidabilis*) have a large number of efferent nephridial ducts, and in one species (*A. drepanophoroides*) the intestinal

[1] *A. marmoratus* from Europe (Joubin, '**90**, p. 564) and *A. arcticus* from Davis Strait (Punnett, :**01**, p. 94).

caecum is stated by Griffin ('**98**, p. 214) to be wanting. A species from the Arctic Ocean (*A. macracanthus*) can be readily distinguished from all other known species of the genus by the comparatively enormous size of the basis of the central stylet — the basis alone measuring about a millimeter in length or one eighteenth the total length of the body of the worm when contracted. And, finally, a single species (*A. gelatinosus*) from a depth of 159 fms. is remarkably gelatinous and probably somewhat hyaline in life, and is well suited for an existence at a considerable depth of water.

It is hoped that in the near future further collections will furnish a sufficient number of well preserved specimens of those species which are still imperfectly known anatomically, because of the absence of the proboscis or for other reason, so that the conspicuous gaps in even this small comparative table may be filled up, and a complete table containing a much wider range of characters may be possible.

53. **Amphiporus angulatus** (Fabr.) Verrill.

Fasciola angulata O. Fabricius, Müller's Verm. Terrest. et Fluv., **1**, p. 58, 1774.

Omatoplea stimpsonii Girard, in Stimpson, Invert. of Grand Manan, Smithsonian Contributions to Knowledge, **6**, p. 28, 1853.

Cosmocephala beringiana Stimpson, Proc. Phil. Acad., p. 165, 1857.

Amphiporus angulatus (Fabr.) Verrill, Trans. Conn. Acad., **8**, p. 390, 1892.

Amphiporus angulatus Coe, Proc. Wash. Acad. Sci., **3**, p. 41, Pl. 6, fig. 4; Pl. 7, fig. 2; Pl. 11, fig. 2; Pl. 13, fig. 3, 1901; Harriman Alaska Expedition, **11**, p. 41, 1904.

Pl. **1**, figs. 5, 6; Text-figs. 19, 46, 47.

This common and widely distributed species may be recognized by the following brief diagnosis: — Body of large size, short, stout and flattened in ordinary states of contraction. When disturbed the worms can become so greatly thickened anteriorly that the transverse diameter in this region is nearly one third as great as the length of the body. Length up to 20 cm. or more; width sometimes 10 mm., although most individuals are less than half these

measurements. Often sexually mature when 15–25 mm. in length, and 2–3 mm. in width.

Color.— Dark brown, reddish brown, or purplish brown on dorsal surface, with paler margins and conspicuous, angular whitish spot on each side of head (Pl. 1, fig. 5), continuous with color of ventral surface. A narrow V-shaped whitish marking extends across body just back of head, and a narrow transverse line is situated on each side near tip of snout (Text-fig. 46). Ventral surface whitish with tinge of gray or purple (Pl. 1, fig. 6).

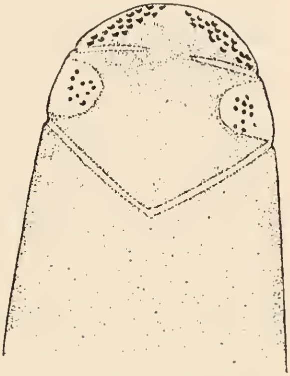

FIG. 46.—*Amphiporus angulatus.* Dorsal side of anterior portion of body, showing markings on head and arrangement of ocelli.

Ocelli.— A pair of elongated clusters containing upwards of 20 small ocelli are situated on the antero-lateral borders of the head, and a smaller, posterior group of 8 to 15 ocelli lies in or near the angular white spot on each lateral margin of head (Text-fig. 46).

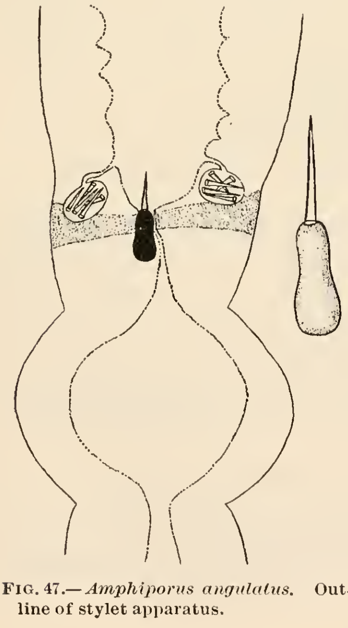

FIG. 47.—*Amphiporus angulatus.* Outline of stylet apparatus.

Proboscis. — Large and thick; pale reddish or salmon in color; armed with moderately slender central stylet and 2 (rarely 4) pouches of accessory stylets, each containing 3 to 7 rather slender stylets. Basis about the same length as stylets (Text-fig. 47). Usually there are 18 proboscidial nerves, although 19 or 20 are sometimes found, and I have seen a single specimen from Maine which had but 17.

Cerebral sense organs well developed, situated immediately in front of brain.

Cephalic and submuscular glands remarkably well devel-

oped (Text-fig. 19), the latter extending backward well toward posterior end of esophageal region.

Intestinal caecum, with pouch-like diverticula, extends nearly to brain.

Nephridia extend from near brain well back in esophageal region, with one or two pairs of efferent ducts in anterior portion of this region.

Habitat. — The species is extremely abundant along the whole Alaska coast as far west as Unalaska Island, and Stimpson ('57) records it from Bering Strait. It is found under stones between tides in all sorts of situations. Stimpson's specimens came from a depth of five fathoms. The species is found on the Atlantic coast of North America from Massachusetts Bay to Greenland (Coe, :01, p. 44).

In addition to the specimens collected on the Harriman Expedition, the following localities are represented in these collections: —

1. Sitka, Alaska. 2 specimens of fair size. Griffin, July, '97.

2. Security Bay, Alaska. 1 specimen. W. H. Jones, Dec., '81.

3. Belkoffsky, Alaska Peninsula. Fragments which probably belong to this abundant and widely distributed species. 15–25 fms. W. H. Dall.

4. Saldovia, Cook Inlet. 2 large specimens, the colors of which are well retained. U. S. F. C. S. Albatross.

5. Bering Strait, 13 fms. 2 small specimens.

6. Near Indian Point, Siberia, 17 fms. 1 small specimen. W. H. Dall.

7. Plover Bay, Siberia, 10–25 fms. 2 rather small specimens. W. H. Dall.

8. Same locality and collector, 10–25 fms. 2 medium sized specimens.

9. "Alaska" U. S. R. S. Corwin, 1884.

10. Copper Island, Commander group (off Kamchatka), L. Stejneger, 1897; 5 small specimens which I could not distinguish from this species.

11. Griffin ('98, p. 212) records the species with a query from Sitka.

12. Bering Sea, near Unalaska Island (Sta. 3311, 53° 59′ N. Lat., 166° 29′ W. Long.), 85 fms., green mud, U. S. F. C. S. Albatross, 1890.

The present known range of this widely distributed species is thus found to be from Massachusetts Bay to Greenland on the Atlantic coast, and from Puget Sound along the whole Pacific coast of Alaska, including its large bays and islands, to the Aleutian Islands, thence to the Commander Islands near the coast of Kamchatka, to Plover Bay, Siberia, and through the Bering Strait. All these localities are characterized by very cold water, and the form is not unlikely to prove a circumpolar, arctic form which extends southward along the eastern and western coasts of North America and eastern coast of Siberia to the latitude of 42°, 48°, and 55°, respectively. This range will doubtless be further extended by future collections.

The species is apparently most abundant between tides, but occurs at a depth of at least 85 fathoms. On the Atlantic coast the species is found much farther south beneath the cold Arctic currents than on the shore between tides, as is the case with most other arctic marine invertebrates.

54. **Amphiporus bimaculatus** Coe.

Proc. Wash. Acad. Sci., **3**, p. 44, Pl. 1, fig. 4; Pl. 5, fig. 10; Pl. 8, fig. 2; Pl. 12, fig. 2, 1901; Harriman Alaska Expedition, **11**, p. 44, 1904.

Pl. **2**, fig. 21; Pl. **18**, figs. 116–118; Pl. **22**, figs. 154–156; Text-figs. 10, 48.

This form, which has previously been recorded from Puget Sound and Alaska, has now been found on the coast of California. It may be recognized by the following brief diagnosis:[1] — Body rather short, stout, broad, flattened both above and below, tapering gradually towards both extremities (Pl. **2**, fig. 21). Head usually somewhat pointed, narrower than body, from which it is demarcated by conspicuous nuchal grooves of remarkably large size and fluted or

[1] Mr. J. F. Abbott, formerly of Stanford University, has kindly sent me a colored drawing of the living worm and two sketches showing the peculiarities of the characteristic nuchal groove. These are reproduced in Pl. **2**, fig. 21, and Pl. **18**, figs. 116, 117. I am also indebted for interesting notes on the species both to him and to Prof. C. B. Wilson, of Westfield, Mass.

transversely striated in a very characteristic manner (Pl. **18**, fig. 117). They lie just back of head, are narrow near median line, widening as they pass laterally directly across the dorsal surface, thence passing to ventral surface where they bend anteriorly (Pl. **18**, fig. 116) on the ventral side of head, and terminate near the median line about half way between their posterior portions and the tip of snout.

Length of body commonly 4 to 15 cm.; width 2 to 6 mm.

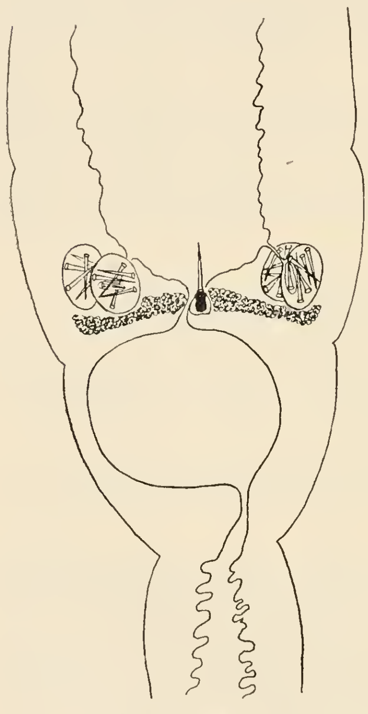

FIG. 48.—*Amphiporus bimaculatus.* Outline of stylet apparatus of proboscis, with four pouches of accessory stylets.

Ocelli. — Usually 12 to 20 (occasionally 25 to 30) large ocelli lie on each side of head, arranged in an irregular, elongated cluster or very irregular row on each antero-lateral margin, and extending inward in the brain region behind the dark cephalic markings (Pl. **18**, fig. 117).

Color. — Dorsal surface of body back of head deep red, brownish red, or brownish orange, sometimes with a more decided tinge of yellow. Head whitish or flesh color, with two angular or oval, black or very dark brown spots, placed symmetrically on dorsal surface (Pl. **2**, fig. 21). A narrow longitudinal line of dark color often occurs in median line on dorsal surface of esophageal region. Mr. Abbott informs me that in some specimens the nuchal groove above described is purplish in color, shading gradually into the red color of body. He also states that the posterior tip of body is often distinctly white in color.

Whole ventral surface pale reddish, pale orange, or flesh color.

Proboscis. — In the California specimens there are either two or

four pouches of accessory stylets, while in the Alaska individuals there are usually four (Text-fig. 48). Central stylet very long and slender, of twice the length of the remarkably small basis (Pl. **18**, fig. 118). There are either 14 or 16 proboscidial nerves (Text-fig. 10), half of which number enter the proboscis from each side at its place of attachment.

Cephalic glands moderately developed. Submuscular glands occur in a limited area, near lateral margins of body in anterior esophageal region. They are of large size, but are much scattered and very few in number.

Alimentary canal.— A rather extensive esophageal caecum extends beneath the stomach. It branches off from the esophagus proper shortly behind the brain as a small canal which enlarges posteriorly until it is as large as the stomach beneath which it lies. It terminates blindly posteriorly somewhat behind the anterior ends of the intestinal caeca, as is the case also with *A. occidentalis.* The stomach extends posteriorly as a long, slender pylorus, which does not open into intestine until far back of most anterior sexual glands.

Intestinal caeca extensive and much branched, extending forward well towards the brain.

Nephridia.— Situated in region of esophageal caecum, with a single pair of efferent ducts.

Cerebral sense organs situated beside brain and extending as large lobes directly posterior to the dorsal brain lobes.

Habitat.— Sitka, Alaska; Victoria, B. C.; Puget Sound (Coe, :**01**). Collected by Mr. J. F. Abbott and by Prof. C. B. Wilson at Pacific Grove, California. Found among crevices of rocks at low tide. Not very common. The worms secrete an enormous amount of mucous.

55. **Amphiporus tigrinus** Coe.

Proc. Wash. Acad. Sci., **3**, p. 46, Pl. 4, figs. 5–8; Pl. 8, fig. 4; Pl. 10, figs. 3, 4, 1901; Harriman Alaska Expedition, **11**, p. 46, 1904.

Pl. **25**, fig. 201; Text-fig. 49.

Body moderately slender for genus, commonly 8 to 10 cm. in

length when sexually mature. Ocelli number perhaps 20 or more on each side of head; they are irregular in shape and variable in size, and are arranged in two irregular and indistinctly separated clusters on each side of head (Text-fig. 49).

FIG. 49. — *Amphiporus tigrinus.* Dorsal view of anterior portion of body, cleared in cedar oil, showing position of ocelli, brain, proboscis, and ovaries.

Color of body of various shades of lemon, yellow, and yellowish brown, much influenced at time of sexual maturity by color of genital products, giving rise to marked sexual color varieties. When sexual products are mature, the prevailing color of females is yellowish orange obscured to a great extent, except in esophageal region, by the dark olive green color of the mature ova. The dark green ovarian pouches commonly appear as irregular lateral transverse stripes of dark green alternating with the yellow color of body. Males are pale yellowish with a slight tinge of greenish, and when sexually mature the spermaries appear as numerous cream colored dots. The position of proboscis sheath is indicated in esophageal region by a narrow median longitudinal dorsal stripe of brownish color in both sexes.

Proboscis armature remarkably weak; central stylet small and short, but acutely pointed; basis short, thick, rounded behind, of double the length of stylet (Pl. 25, fig. 201). There are commonly about 5 accessory stylets in each of the two lateral pouches. Glandular wreath about stylet region of a deep green color, which persists even after mounting in balsam.

Cerebral sense organs small, situated slightly in front of brain. Intestinal caecum broad, but terminates anteriorly far behind brain region.

Further anatomical peculiarities are given in the paper cited.

Habitat.— As yet known only from Farragut Bay, British Columbia, where it occurs under stones in muddy situations at about half tide (Coe, :01, p. 48).

56. Amphiporus nebulosus Coe.

Proc. Wash. Acad. Sci., **3**, p. 48, Pl. 4, fig. 1; Pl. 8, fig. 6; Pl. 11, fig. 1; Harriman Alaska Expedition, **11**, p. 48, 1904.

Pl. **22**, figs. 157, 158; Text-figs. 3, 50.

Body of moderate proportions, much flattened; rhynchodaeum opening subterminal. Length commonly 10 to 15 cm.; width 5 mm.

Color. — Dull white or grayish, often with a yellowish tinge, very thickly mottled on dorsal surface with confluent blotches and dots of dark brown color; ventral surface grayish, often with tinge of yellow.

Ocelli. — On each side of head there are commonly 18 to 28 ocelli, arranged in two irregular groups (Pl. **22**, fig. 157). On each antero-lateral margin is a single row of 4 to 6 rather large ocelli, which continues posteriorly into an irregular, marginal group of 8 to 12 smaller eyes; while an irregular cluster of 7 to 10 small ocelli lie just in front of brain and deep in the tissues of the head.

Proboscis.—Provided with usually 17 nerves. Central stylet very slender, of about the same length as basis, which is very broad and flattened posteriorly (Pl. **22**, fig. 158; Text-fig. 50).

FIG. 50.—*Amphiporus nebulosus.* Outline of stylet apparatus of proboscis.

Submuscular glands enormously developed (Text-fig. 3), extending nearly the whole length of esophageal region.

Intestinal caeca extend forward well toward the brain.

Nephridia situated in anterior portion of esophageal region; there is a single pair of efferent ducts, opening ventro-laterally.

Cerebral sense organs well developed, situated in front of brain.

Reproductive organs.— Sexual products mature in July; they

are discharged through ducts situated beneath the lateral margins of body.

Habitat.—Kukak Bay, Alaska Peninsula (Coe, :**01**). Mr. Abbott informs me that specimens of the same species have been sent him from Kadiak Island, Alaska.

57. **Amphiporus cruentatus** Verrill.

Proc. U. S. Nat. Mus., **2**, p. 184, 1879. Trans. Conn. Acad., **8**, p. 399, Pl. 33, figs. 7, 8; Pl. 35, fig. 3, 1892.

Amphiporus cruentatus Coe, Harriman Alaska Expedition, **11**, p. 154, Pl. 20, figs. 1–6, 1904.

Pl. **1**, fig. 13; Text-figs. 12, 20, 51, 52.

This species which has previously been found only in New England is fairly common among various growths on the rocks of the breakwater at San Pedro, California. A number of specimens were also obtained from piles at Monterey, California, in 1901.

Fig. 51.—*Amphiporus cruentatus*. Outline of head, showing comparative size and position of ocelli.

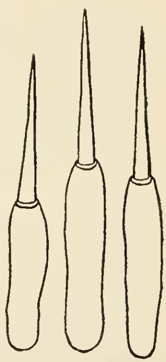

Fig. 52.—*Amphiporus cruentatus*. Outlines of central stylets and bases showing variation in size and form in different individuals.

Body small, soft, rather slender, usually 10–25 mm. in length, of a pale yellow, bright yellow, or sometimes flesh-color, and having very conspicuous vessels with deep red blood, the color of which resides in the large discoid corpuscles. Head slender, with inconspicuous oblique furrows placed far back from tip (Text-fig. 51).

Ocelli usually five to ten on each lateral margin of head (Pl. **1**, fig. 13; Text-figs. 20, 51), usually well separated, irregular in size and position; anterior ocellus on each side distinctly the largest and situated more superficially.

Proboscis very long and large, of a pale, slightly pinkish color. Central stylet slender and acutely pointed, having a very slender basis of about the same length as stylet (Text-fig. 12). Basis peculiar in that it is no wider, and is often narrower posteriorly than at attachment of stylet. It is often irregular in shape (Text-fig. 52) and about five or six times as long as its average width. Measurements vary from 0.07 to 0.1 mm. in length and 0.013 to 0.017 in width. Two pouches of accessory stylets contain from two to four slender stylets each. Proboscis sheath reaches very nearly to posterior end of body. Retractor muscle of proboscis composed of about six strong fibers, attached in two groups to wall of sheath.

Blood system as in related species. In every individual of a large number of specimens the dorsal, or proboscis sheath vessel originated anteriorly from the right lateral vessel (Text-fig. 20).

58. **Amphiporus imparispinosus** Griffin.

Ann. New York Acad. Sci., **11**, p. 210, 1898.

Amphiporus leuciodus Coe, Proc. Wash. Acad., **3**, p. 51, Pl. 7, fig. 6, 1901; Harriman Alaska Expedition, **11**, p. 51, 1904.

Amphiporus leuciodus Punnett, Proc. Zool. Soc. London, p. 95, 1901.

Pl. **16**, figs. 99, 100; Pl. **25**, figs. 195–197; Text-fig. 53.

This abundant and widely distributed species may be recognized by the following characters: — Body small, usually 25 to 50 mm. in length, remarkably slender, slightly flattened posteriorly.

Color opaque white, sometimes with a pale reddish or yellowish tinge, sometimes pale yellow, or flesh-color; brain is pinkish; intestinal canal often has brownish tinge.

Ocelli.— There are two groups of ocelli on each side of head; an elongated, anterior, marginal group of 6 to 15 ocelli, and an irregular, posterior group of about the same number, or, rarely, up to 30 or more lying internal and posterior to marginal groups and immediately anterior to brain (Pl. **16**, fig. 99; Pl. **25**, figs. 195–197; Text-fig. 53). Smaller and evidently younger individuals have much fewer ocelli.

Proboscis provided with central stylet and three pouches of accessory stylets. Central stylet and basis slender and of about equal length (Pl. 16, fig. 100).

Specimens but 10 mm. in length, and evidently very young, had only 3 or 4 ocelli in each marginal group and 4 or 5 in each cerebral cluster (Pl. 25, fig. 196). All had the three pouches of accessory stylets, however. An interesting correlation between size, number of ocelli, and size of stylet apparatus is illustrated by the following measurements: —

Length of body.	*Number of ocelli.*				*Length of central stylet.*	*Length of basis.*
	Marginal group		Cerebral group			
10 mm.	Left 3	Right 3	Left 5	Right 4	.060 mm.	.045 mm.
10	6	7	6	6	.066	.060
15	7	7	9	9	.080	.084
25	16	13	13	15	.096	.120
28	9	10	19	21	.108	.126
45	13	15	29	26	.105	.120

The smallest and evidently youngest individuals therefore, with the smallest number of ocelli, had the central stylet but little more than half the length of that of the larger individuals, while the length of the basis of the central stylet varied nearly three fold between the smallest and largest individual. This correlation does not continue, however, in individuals above medium size, for after the worms have attained a length of about 25 mm. there is comparatively little increase in number of ocelli or size of stylet apparatus, although the *average* in both these particulars is undoubtedly greatest in individuals of the largest size. The proboscis is usually provided with about 15 nerves.

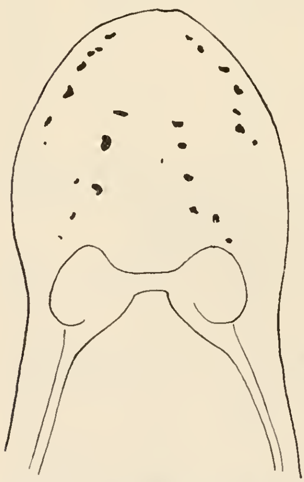

FIG. 53.—*Amphiporus imparispinosus.* Outline of head, showing position of ocelli.

Cerebral sense organs small, situated well in front of brain.

Nephridia remarkably extensive, reaching from brain region backward beyond the first few pairs of reproductive glands; with numerous efferent ducts. Usually 5 to 10 efferent nephridial ducts on each side, of which several of the more posterior ones open on dorso-lateral surfaces of body, the others opening ventro-laterally.

Habitat. — Very abundant among algae between tides and on piles of wharf, Victoria, B. C., and southern Alaska (Coe, :**01**); Puget Sound, and Sitka, Alaska (Griffin, '**98**).

Common also among shells and algae at the breakwater, San Pedro Harbor, California.

This is the most abundant of all species of nemerteans found at Pacific Grove, California, occurring among rocks and algae fully half way from low tide to high-water mark.

Copper Island (Commander group), Siberia; collected by Prof. D'Arcy Thompson. These specimens were peculiar in having but 12 proboscidial nerves and in having 10 to 12 efferent nephridial ducts on each side, all of which opened ventrally (Punnet, :**01**, p. 95).

Bering Island (Commander group), Siberia, collected by Dr. L. Stejneger on beach, August, 1897.

Port Providence, Plover Bay, Siberia (near Bering Strait). Collected by E. P. Herendeen, August, 1880.

The present known range of this very common species is therefore from San Pedro, California, to Puget Sound, to Alaska, to the Commander Islands off the coast of Kamchatka, to Bering Strait. This range represents an extent of more than 5,000 miles of coast line and extremely different environmental conditions, the water at San Pedro being constantly at a temperature of at least 50–70° F., while that in Bering Strait is covered with pack-ice during a considerable portion of the year and is never much above the freezing point.

59. **Amphiporus similis**, sp. nov.

Pl. **16**, figs. 93, 94; Pl. **22**, figs. 152, 153.

Body small, slender; usually only 8 to 15 mm. in length and less than 1 mm. in width. Head rather slender, with two pairs of lateral oblique furrows as usual.

Color. — White with tinge of pinkish or yellowish; intestine and intestinal caeca, the latter extending nearly to brain, very pale yellow or slightly brownish.

Ocelli. — Usually 6 to 12 ocelli on each side of head, arranged in two groups on each side as in *A. imparispinosus*, except that the anterior ends of posterior groups often appear to lie externally to posterior ends of anterior groups. Each of the four groups has about the same number of ocelli (Pl. **16**, fig. 93; Pl. **22**, fig. 152).

Proboscis. — Proboscis sheath extends very nearly to end of body and contains numerous flattened, colorless corpuscles. Proboscis attached to wall of sheath a little posterior to middle of body by means of root-like fibers. Provided with slender central stylet and two pouches each containing 1, 2 or 3 similar accessory stylets. Basis of central stylet slender, a little more than twice as long as wide, and usually a trifle shorter than the stylet itself. Measurements of several bases and stylets give a length of basis from .035 to .063 mm., with a width of .017 to .027 mm., while stylet itself is commonly .036 to .075 mm. in length, and acutely pointed (Pl. **16**, fig. 94; Pl. **22**, fig. 153). There are 10 proboscidial nerves.

Brain large, pale in color; *cerebral sense organs* are about two thirds the diameter of dorsal ganglia, and are situated a little more than half way from tip of snout to brain.

Habitat. — Monterey, California, on piles; Pacific Grove, among corallines.

This minute species is common in the localities mentioned, as is also *A. imparispinosus*, with which it is associated, and the young individuals of which it very closely resembles. It can hardly be distinguished without examination of proboscis, which always contains but two pouches of accessory stylets, while that of *A. imparispinosus* has three even when young. The number of proboscidial nerves is also very different in the two species.

60. **Amphiporus formidabilis** Griffin.

Ann. New York Acad. Sci., **11**, p. 211, 1898.

Amphiporus exilis Coe, Proc. Wash. Acad. Sci., **3**, p. 54, Pl. 3, fig. 1; Pl. 8, fig. 5; Pl. 11, fig. 3, 1901; Harriman Alaska Expedition, **11**, p. 54, 1904.

Pl. **17**, figs. 101, 102; Text-figs. 13, 15, 23, 54.

This very common and widely distributed species may be recognized by the following characters: — Body remarkably slender for

genus, rounded, of nearly the same diameter throughout; head somewhat wider than neck when well extended. Mature worms are usually 10 to 30 cm. in length and 2 to 3 mm. wide.

Ocelli. — Ocelli small, but exceedingly numerous, numbering 150–250 in very large individuals; small specimens may possess less than 50, and those of medium size from 70 to 100. They are arranged in two elongated clusters on each side of head — an anterior, marginal cluster on each antero-lateral border of head, and a posterior, cerebral cluster lying somewhat posterior to the marginal group and nearer the median line. Each of the posterior clusters meets its fellow in the median line to form a single V-shaped group with the apex directed anteriorly (Pl. **17**, fig. 102; Text-fig. 23). The two marginal clusters likewise converge nearly to the middle line at the tip of the snout.

Color. — Color opaque white, very pale flesh color, pale yellowish, or pinkish drab, through which the intestinal canal is conspicuous because of its drab, brownish, or, occasionally, pale orange color. Brain is distinctly reddish, as are also the lateral nerves which appear as reddish or yellow lines on each side of body.

Proboscis. — Remarkable in having 6, 8, or 12 pouches of accessory stylets, each with one or two slender stylets (Pl. **17**, fig. 102; Text-fig. 13). Most individuals have either 8 or 12 accessory pouches, those with but 6 being comparatively rare. Central stylet slender, basis massive (Text-fig. 54). In a rather small individual the central stylet measured 0.126 mm. in length; basis was 0.24 mm. long and 0.13 mm. wide in its widest portion. There is considerable variation in size of stylet apparatus in different individuals, however. In most specimens the stylet is from one half to three fifths the length of the basis. There are usually about 30 proboscis nerves.

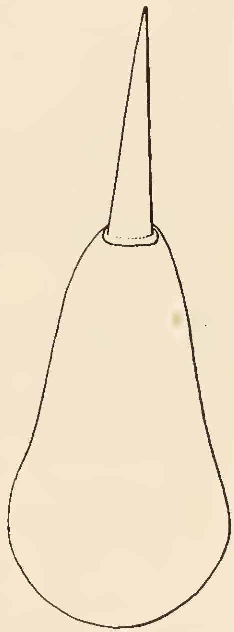

Fig. 54.— *Amphiporus formidabilis.* Outline of central stylet and basis of large individual. × 175.

Cephalic and submuscular glands are very highly developed.

Nephridia are peculiar in being remarkably extensive and in having upwards of 20 or more efferent ducts on each side, nearly all of which open on the dorsal aspect of the body (Text-fig. 15).

Intestinal caeca voluminous, extending anteriorly as far as posterior end of brain.

Cerebral sense organs situated well in front of brain.

Habitat. — (1) Pacific Grove and Monterey, California, in crevices of rocks and among algae. Not very common.

(2) Puget Sound and Alaska (Griffin, '98, p. 211).

(3) I have found this species abundant at nearly all the collecting stations of the Harriman Alaska Expedition from Victoria, B. C., along the whole Pacific Coast of Alaska to Dutch Harbor, Unalaska Island.

(4) Saginaw Bay, Alaska. Low tide, Dr. W. H. Jones, Dec., 1881.

(5) "Portage Bay," Alaska. A single specimen, which *appeared* to have 16 pouches of accessory stylets, but I am not positive that some of the stylets had not slipped out of place, and that there were actually more than 12 pouches in life.

(6) Security Bay, Alaska. Dr. W. H. Jones. The single specimen had 8 pouches of stylets, each containing one mature and one immature stylet.

(7) Unalaska Island. Collected by the Albatross.

(8) Adakh Island (Aleutian Group). July, '93, Albatross.

(9) Atka Island (Aleutian Group). Albatross.

The distribution of this species, so far as known at present, is therefore from Monterey Bay, California, to Puget Sound to British Columbia, and along the whole Pacific Coast of Alaska to the Aleutian Islands. I have collected the species personally at numerous localities along these 3000 miles of coast line. The region of greatest abundance, as indicated by my own observations, is in British Columbia and southern Alaska, where the worms live among barnacles, mussels, algae, and other growths from low water well up toward high-water mark, and are found on piles of wharves, under stones and in crevices of rocks in almost all sorts of situations. On cloudy days they are often seen crawling over stones between tides, and are as hardy as they are restless.

61. **Amphiporus paulinus** Punnett.

Proc. Zool. Soc. London, p. 92, 1901.

Amphiporus paulinus Coe. Harriman Alaska Expedition, **11**, p. 155. 1903.

This species is described by Punnett as being a slender form, 50–90 mm. in length and up to 4 mm. in greatest diameter.

Color in life unknown, but after preservation the worms assume a pale yellowish brown color dorsally, and are almost white ventrally.

Submuscular glands well developed, reaching back to intestine. Intestinal caeca do not extend nearly to brain.

Proboscis sheath extends only about six sevenths the length of the body; the proboscis is about three fourths as long as body and contains 15 nerves. Its armature consists of central stylet and 2 pouches with 4 reserve stylets each. Basis is of same length as central stylet. A single efferent nephridial duct lies on each side. Cerebral organs in front of brain. There are numerous ocelli.

Habitat.—Collected by Professor D'Arcy Thompson, Pribilof Islands, Bering Sea (Punnett : **01**).

No specimens answering this description have come into my hands from any of the numerous collections made in Alaska, although I have seen no nemerteans from the islands indicated. This species is quite distinct from any other known form of the genus, which is so abundantly represented on the west coast of North America.

62. **Amphiporus punctatulus**, sp. nov.

Pl. **21**, figs. 129–140; Pl. **24**, fig. 194.

Head and anterior portion of body rather narrower than parts farther back, but head is not marked off from rest of body. A pair of shallow oblique grooves lie upon sides of head as usual. Posterior portion of body flattened dorso-ventrally; posterior extremity much flattened, with rounded posterior outline.

Size.—The fifteen specimens contained in the two lots mentioned below were all between 35 and 50 mm. in length, and about 4 mm.

in width. When partially contracted the body is short and compact, as in *A. angulatus*.

Color. — In the alcoholic specimens the whole surface of the body is dark mottled brown, the color consisting of innumerable dark dots which run together, forming irregular blotches. The dark markings are so closely placed as to nearly obscure the paler ground color. The mottling is less complete on the ventral surface, so that the ground color is revealed. The pigment resides wholly in the integument, and is easily removed by rough handling.

Ocelli. — The eyes are arranged in two groups on each side of head, and are of fairly large size. An anterior, marginal group of 10–16 ocelli on each side is arranged (when the head is extended) in an irregular row which becomes broken up posteriorly into an irregular cluster (Pl. **21**, figs. 129, 130). The posterior, or cerebral groups each consist of about 3 to 6 ocelli overlying the brain. When the head is contracted the marginal groups of ocelli consist simply of irregular clusters reaching inward well toward the median line.

Proboscis. — Proboscis sheath extends nearly the whole length of the body, as described below. Proboscis large; when extruded it is often more than three fourths the length of the whole body; without color after preservation; often everted when animal is killed.

There are two pouches of accessory stylets, with 5, 6, 8, or more stylets each (Pl. **24**, fig. 194). These are dagger-shaped and symmetrical, with cores of granular nature, covered with a clear and homogeneous sheath (Pl. **21**, figs. 137, 139, 140). They measure with great constancy about .234 mm. in length by .024 mm. in width in their middle portions.

The central stylet is exactly similar in size and shape to the lateral stylets. The basis is barrel-shaped (Pl. **21**, figs. 136, 138), but is slightly broader at the end farthest from the insertion of the stylet. The basis is remarkably short and thick, being less than half the length of the stylet itself. It measures but 0.105 mm. in length, and is 0.075 mm. wide at its posterior end.

The proboscides of six individuals were sectioned. Of these, four were provided with 13 nerves each, while each of the two others had but 12. The nerves were rather large and conspicuous; muscular and epithelial layers as in other species.

Body walls.— The posterior portions of body are very much flattened dorso-ventrally (Pl. **21**, figs. 132, 133), thereby enabling the worms to swim readily. This flattening is brought about by a great development of dorso-ventral muscular fibers passing from the dorsal to the ventral portions of the body walls between the intestinal lobes, as in CEREBRATULUS. These muscles are found to continue to the very extremity of the body; posteriorly to the intestine proper they lie between the rectum and the lateral nerves (Pl. **21**, fig. 132).

A distinct set of diagonal muscular fibers lies just inside the circular muscular layer of the body walls, as in some other species of the genus. They run obliquely to the other muscles of the body, and in reality are disposed in two separate layers of fibers which are directed at right angles to each other, as are the diagonal muscles in CEREBRATULUS, CARINOMA, and other forms.

These diagonal muscles are most conspicuous in sagittal sections of the body, especially in the esophageal region, and the fact that the two sets run at right angles is here very evident. In cross sections, however, they are by no means difficult to observe, for they are separated from the circular muscles by a thin sheet of connective tissue, somewhat as in *Carinoma mutabilis* (Pl. **12**, fig. 79).

The individual muscle bundles of the longitudinal muscular layer are well separated in the esophageal region, and especially above and below the lateral nerves, by broad outgrowths of the connective tissue of the body cavity which reach outward quite to the circular muscular layer.

Posterior end of body.— The greatly flattened posterior extremity shows some interesting peculiarities, which should be described in detail. The proboscis sheath retains its thick walls until near the end of the body. It then becomes very small, its lumen gradually disappears, but its musculature is prolonged some little distance farther back, and is eventually lost in the longitudinal muscles of the body walls.

The dorsal blood vessel remains beneath the proboscis sheath throughout the length of the latter, but a little farther back enters into a broad and conspicuous anastomosis with the pair of lateral vessels at their extremities. This anastomosis lies above the intestine, as figured for *A. angulatus* (Coe, :**01**, Pl. 13, fig. 3).

The lateral nerves remain of large size beyond the end of the

proboscis sheath and beyond the blood vessels. As shown in Pl. 21, fig. 132, they here lie in the midst of the body parenchyma, about half way between the rectum and the circular muscles. Their union above the rectum is very conspicuous and lies some little distance posterior to the anastomosis of the blood vessels.

At the posterior end of the intestine proper (or mid-gut) its lateral lobes quite disappear, and the short rectum following has a very small lumen (Pl. 21, figs. 132, 134). In this region a very considerable number of circular muscular fibers appear, surrounding the rectum (Pl. 21, Text-fig. 132), and these increase so greatly in number farther back as to form a marked inner circular layer (Pl. 21, figs. 133, 134). The extent of these muscles is short, for they first appear as a distinct layer near the posterior end of the rectum. They are, however, of considerable interest, for they seem to be homologous with the inner circular layer which is developed about restricted portions of the alimentary canal in some other nemerteans of widely different orders. In MICRURA, for instance, and especially in ZYGEUPOLIA (Thompson, :02) a distinct layer of circular muscles is found closely fitting about the posterior end of the esophagus; in CARINOMA a similar layer becomes massively developed in a corresponding region.

As has been stated for *Micrura alaskensis* (Proc. Wash. Acad., 3, p. 73, 1901), I am disposed to consider all these muscular thickenings as merely excessive development in localized areas of the extremely thin and delicate muscular tunic (in many instances difficult to demonstrate) which extends throughout the length of the alimentary canal in many, if not all, species of nemerteans. In the present species the thickening of these muscles occurs at the posterior end of the rectum, instead of at the posterior end of the esophagus as in the other forms mentioned.

Just at the anastomosis of the lateral nerves this inner circular (or intestinal) muscle becomes several times as thick as the main circular layer of the body walls. Behind the nerve anastomosis all the muscular layers become interrupted and intermixed with large numbers of oblique fibers. But still the inner circular muscle is clearly distinguishable from the main circular layer (Pl. 21, figs. 133, 134) and is several times as thick. At the nerve anastomosis the parenchyma of the body cavity is discontinued, and behind this point the muscles fill all the space between the integument and the

narrow rectum. Near the posterior opening of the rectum practically all the muscles are circular, and this insures a well developed sphincter. A similarly thick circular muscle is described for a corresponding region in *Taeniosoma punnetti* (p. 13).

A section near the posterior opening of the rectum (Pl. **21**, fig. 133) shows how very thick is the integument as compared with the other tissues, and especially with the minute lumen of the rectum.

Cephalic glands are voluminous (Pl. **21**, fig. 131).

Submuscular glands are abundant along the lateral borders of the head in the brain region, but do not continue far back into the esophageal region.

Alimentary canal.— The rhynchodaeum opens subterminally; esophagus soon separates from proboscis sheath, and stomach is unusually small. A broad intestinal caecum lying beneath the pylorus reaches far forward into the esophageal region, as in other species of the genus, while just back of the nephridia, and occupying the same relative position, lies a pair of lateral diverticula of this caecum. Back of the point of origin of this anterior pair of diverticula similar lateral lobes are given off from the caecum at fairly regular intervals back as far as its origin from the intestine proper, where they are replaced by the corresponding intestinal pouches. The pylorus becomes of very small diameter toward its posterior end and opens into the dorsal wall of the intestine as usual.

The rectum is of small size, without lobes, and is provided with a peculiar circular muscular layer, as described above (p. 256).

Nephridia. — In extent and profusion of branches the nephridial system is remarkable. From near the brain (Pl. **21**, fig. 131) a complex series of branching tubules extends back about one half the length of the esophageal region. The tubules lie imbedded in the body parenchyma just internal to the lateral nerves, and extend some little distance both dorsally and ventrally. In cross section they cover an area several times as great as that of the lateral nerve. The tubules lie in close contact with the walls of the lateral blood vessels, which seem to be imbedded in the nephridial mass. There is a single pair of large efferent ducts.

Blood system much as in other species of the genus. Median vessel projects freely into cavity of proboscis sheath for some little distance back of the brain, and then lies beneath the sheath throughout the rest of the body. The union of the three longitudinal vessels near the posterior end of the body has been described above.

Sense organs. — The ocelli are of rather large size. Most of them lie near the dorsal and lateral margins as usual, but some are situated deeper in the tissues of the head and close beside the brain (Pl. **21**, fig. 131).

The cerebral sense organs are remarkably voluminous (fig. 131). They lie lateral to the dorsal ganglia and close beside them, but extend posteriorly behind the ganglia, and abut closely against the posterior faces of the latter. They each communicate with the exterior by a large canal which passes forward in front of the brain and opens ventro laterally as usual.

Parasites. — In each of the three specimens sectioned the whole body, including brain, lateral nerves, muscles, proboscis sheath and proboscis, body parenchyma, basement layer, and epithelium, is infested with countless numbers of small oval parasites which stain deep blue with haematoxylin. These appear to belong to a species of Gregarinae. They are about .02 mm. in length by .006 mm. in diameter, and hundreds of them occur in a single section. They are most abundant in the anterior portions of the body, but are present quite to the tip of the tail.

Habitat. — Fifteen specimens of this new and interesting species were collected by the U. S. F. C. steamer Albatross at Isthmus Cove, Catalina Island, California. The label states that they were "taken in the surface net with an electric light" on April 9th, 1897. Two lots of specimens contained similar labels. From this we must infer that we have at hand a species of more or less pelagic nature, which leaves its burrows on occasion and swims about at the surface of the sea, as do some species of Cerebratulus (*C. lacteus* of the New England waters, for example). Indeed, the posterior portion of the body is remarkably flattened, as is described above, and its structure well adapts the animal for swimming. It would scarcely be expected that the worms would be found at the surface, except at the period of sexual maturity, unless the species were wholly pelagic, yet none of these specimens contained mature sexual products. At the same time, I do not think we are warranted in considering this a truly pelagic form, for the structure of the body is closely similar to that of other species living under stones and in burrows, and is widely different from that of other known pelagic nemerteans. There remains the final possibility that the same error occurs in both labels and that the specimens actually came from

other situations than that stated. Until other specimens have been collected, the view that the species is but temporarily free-swimming seems most reasonable. From the use of the electric light, we must infer that the specimens were taken in the evening, although the hour is not stated.

63. **Amphiporus gelatinosus**, sp. nov.

Pl. **19**, figs. 119, 120; Pl. **20**, figs. 122–127; Pl. **25**, fig. 204.

Body broad and much flattened after preservation, its widest part not far back of head; head rather narrow, but a little wider than parts immediately following, demarcated from body by a pair of conspicuous lateral furrows which reach dorsally well toward the median line (Pl. **25**, fig. 204). The single specimen measured after preservation about 75 mm. in length, 6 mm. in width, and about 3 mm. in thickness.

Color. — In general appearance the specimen is somewhat translucent and gelatinous. It is perfectly colorless and gives the impression that it was whitish in life, but this is, of course, only a supposition.

Ocelli. — On each side of the head is a broad cluster of thirty or more large ocelli. These are scattered irregularly on each side and reach from near the proboscis pore back nearly to the lateral, transverse furrows (Pl. **25**, fig. 204). As seen in sections, the ocelli lie mostly directly beneath or imbedded in the longitudinal muscles of the head (Pl. **19**, fig. 119). They are provided with large nerves.

Body walls. — In cross section of the body the most striking peculiarity is the enormous development of the gelatinous tissue or parenchyma, which fills up a broad space between the muscular layers of the body and the intestine, proboscis sheath, and other organs (Pl. **19**, figs. 119, 120). The muscular layers are as in other species of the genus, but are very thin as compared with the diameter of body.

In no other described species of the genus is the parenchyma developed to such an extent as in the present species. In the esophageal region (Pl. **19**, fig. 120), the parenchyma is several times as voluminous as the stomach, and even in the intestinal region (Pl. **20**, fig. 122) is but little less highly developed. This great mass

of gelatinous tissue extends forward, making up the great bulk of the substance of the head. Even near the tip of the snout the muscular layers are thin in comparison with this tissue. In the region of the brain (Pl. 19, fig. 119) this mass of tissue is many times as thick as the muscular layers. To be sure, a very few muscular strands pass diagonally across the tissue from one side of the head to the other, but the great bulk of its substance consists of a jelly-like matrix with a few small nuclei and a small number of strands of fibrous connective tissue.

The elements making up this parenchyma are similar to those which Montgomery ('97, pp. 1–37) has so fully described for Cerebratulus and other genera. Many of the cells of this tissue possess small oval nuclei and send out irregularly branching processes (Pl. 20, fig. 124) in all directions. These branching cells ramify through the gelatinous substance in which they are suspended, and their processes often unite into an irregular network, as Montgomery has described. The cell bodies are commonly filled with vacuoles and granules of irregular sizes. The protoplasmic boundaries are often so faintly marked that it is impossible to determine the exact extent of the cell body. A number of these cells taken from a section through the region of the brain are shown in Pl. 20, fig. 124. These illustrate the great variety of form exhibited by the ordinary parenchyma cells of the gelatinous tissue.

Proboscis not present in the preserved specimen, so that nothing is known of its structure.

Cephalic glands. — A very large cluster of cephalic glands lies directly dorsal to the proboscis opening, and smaller clusters lie on each side. They are all limited to the tip of the snout, however, and extend posteriorly scarcely more than six to eight sections.

Submuscular glands. — These are also highly developed, and are thickly packed in among and beneath the clusters of fibers in the longitudinal muscular layer. The abundance of these glands in the cephalic portion of the body is remarkable, and in certain regions they form a layer more than equal in bulk to the longitudinal muscular layer. In Pl. 20, fig. 123, the relation of the glands to the muscle bundles is shown. This section was taken from the brain region, and shows a greater mass of glands than of muscle fibers. The ducts of the glands pierce the circular muscular and basement layers to open through the integument to the surface of the body as usual.

The submuscular glands extend posteriorly but little beyond the brain region, and are always buried more or less deeply in the longitudinal muscular layer, never projecting freely into the underlying gelatinous tissue of the body cavity. As in other species, the glands are multicellular, a dozen or more nuclei, without definite cell boundaries, being commonly seen in a single section of one of the glands.

Alimentary canal. — The mouth actually opens into the rhynchodaeum, although in the specimen from which the proboscis had been extruded the mouth opening was so near the anterior end of the latter as to be almost independent of it. In the region in front of the brain the esophagus is large, and is lined with columnar, ciliated epithelial cells, while the rhynchodaeum is very much smaller and is lined with flattened cells (Pl. **19**, fig. 119).

The esophagus passes gradually into the stomach, which throughout its length is small in comparison with the diameter of the body. It lies near the ventral wall of the body, and is widely separated from the lateral and dorsal body walls by the remarkably voluminous gelatinous tissue described above (Pl. **19**, fig. 120).

The intestine exhibits the usual paired lateral diverticula, but these do not reach nearly to the body walls; everywhere they are surrounded by a very thick layer of this gelatinous tissue (Pl. **20**, fig. 122), which is scarcely less voluminous here than in the esophageal region.

The intestinal caeca are but slightly developed. The pylorus is short, and at its opening into the dorsal wall of the intestine a broad intestinal caecum passes forward beneath the stomach. This does not extend far anteriorly, however, but soon breaks up into secondary branches of small size which lie beside the stomach (Pl. **19**, fig. 120). These branches reach anteriorly only about as far as the posterior efferent nephridial ducts which are situated far behind the brain.

Nephridia. — The nephridial tubules extend forward about as far as the middle of the brain lobes. Posterior to the brain a multitude of fine canals ramify through the parenchyma of the body cavity. They lie mainly above the lateral nerves and penetrate the gelatinous tissue in all directions, extending from the muscular layers of the body walls inward to the stomach and proboscis sheath (Pl. **19**, fig. 120).

The nephridia extend throughout the whole length of the eso-

phageal region, but in no portion of their course is there a single large tubule as is found in most species of the genus. Throughout their whole extent they consist of fine, branching tubules imbedded in the gelatinous tissue of the body cavity.

In the single specimen, I found two pairs of efferent nephridial ducts. The anterior pair was situated a short distance behind the brain, and opened on the ventro-lateral aspects of the body, as is common in the genus. The second pair was situated some distance further posteriorly and opened directly laterally and far above the lateral nerve cords (Pl. **19**, fig. 120). A somewhat similar condition has been described in but few other species of the genus, but *A. imparispinosus* and *A. formidabilis*, both from the west coast of America (Coe, :**01**, pp. 52, 55), and Geonemertes (Böhmig, '**98**, p. 512) likewise have efferent ducts opening both above and below the lateral nerves. When passing through the body walls, the efferent ducts spread out widely in the circular muscular layer, as has been noted in other species.

Blood vascular system. — The blood vessels show few deviations from the condition found in related species. The blood spaces in the head are small, and are imbedded in the parenchyma (Pl. **19**, fig. 119). The three longitudinal vessels are likewise supported in the same tissue. The cells lining the interior of the blood vessels are very large and have a remarkable affinity for stains, as in some other species.

Nervous system and sense organs. — The brain is voluminous; dorsal commissure of medium size, ventral commissure remarkably large (Pl. **19**, fig. 119). The brain is buried deep in the tissues of the head (as in Taeniosoma), and the lateral nerves at their origin from the ventral ganglia bend outward toward the lateral walls of the body, but do not reach nearly to the muscular layers. General distribution of nerves as in other species of genus. Lateral nerve cords lie in ventral portion of the body, and are imbedded in the gelatinous tissue of the body cavity (Pl. **19**, fig. 120).

The cerebral sense organs are extremely small. They lie in front of the brain and open by short canals to the ventro-lateral aspects of the snout.

The ocelli are highly developed, and show clearly the nerve fibers spreading out inside the pigment cup.

Reproductive organs. — The genital pouches commence at the

point where the pylorus opens into the intestine, but increase in number farther back. The mode of development of the ova is most clearly illustrated in the single specimen sectioned. There is but a single ovum developed in each follicle, and it is a simple matter to find these latter in all stages of development from the undifferentiated germinal epithelium to the follicles with nearly mature ova. The genital glands (Pl. 20, fig. 122) are formed in the outer portions of the parenchyma of the body cavity and just beneath the inner zone of longitudinal muscles, as in other nemerteans.

In the earliest stages that it is possible to distinguish the follicles, they appear as a continuous mass of granular cytoplasm containing several nuclei, but without cell boundaries. One of the nuclei is many times the size of the others, and contains a considerable number of large nucleoli. The whole cytoplasmic mass is surrounded with a delicate membrane, on the inner side of which, and buried in the cytoplasm, are a number of flattened nuclei. The mass of cytoplasm later assumes a conical form, with the apex directed into the muscles of the body walls (Pl. 20, fig. 125).

The single large nucleus mentioned is to form the germinal vesicle of the ovum, and is almost always situated in the portion of the cytoplasm farthest from the apex. The small differentiated nuclei, which belong to the nourishing cells of the follicle, are most abundant near the apex (Pl. 20, fig. 125).

On the side of the germinal vesicle nearest the base of the cytoplasmic mass, a conspicuous and deeply staining yolk-nucleus is present in all except the earliest and latest stages. It is most highly developed, however, when the ova are about half grown, and lies as a broad cap directly against the nuclear membrane. The nucleoli of the germinal vesicle are most abundant in the vicinity of the yolk-nucleus (Pl. 20, fig. 126).

As the cytoplasmic mass increases in size, the greater portion of the cytoplasm surrounding the germinal vesicle gradually becomes separated into a large central mass, which is to form the egg cell, and a thin superficial layer in which a number of small undifferentiated nuclei are situated, and which forms the follicle (Pl. 20, fig. 126). A delicate cell membrane now forms about the greater portion of the egg cell, but the cytoplasm of this cell still remains directly connected with the superficial cytoplasm of the follicle at a number of points. The broadest of these connections lies at the

base of the conical protoplasmic mass, and eventually all the other connections are severed. The ovum is now attached by a broad stalk to the base of the follicle (Pl. **20**, fig. 126), and is separated from the rest of the follicle by a narrow cavity. The germinal vesicle and the yolk-nucleus are always situated near the point of attachment (Pl. **20**, figs. 125–127).

With the growth of the ovum the wall of the follicle likewise increases in thickness, and the cytoplasmic substance becomes much vacuolated with food materials for the ovum. At the region where the ovum is attached these small food vacuoles come directly into its substance in the vicinity of the yolk-nucleus (Pl. **20**, fig. 127).

The yolk-nucleus gradually decreases in staining power after the accumulation of much yolk in the ovum, and at the same time a great increase in the number of nucleoli in the germinal vesicle takes place. The follicular nuclei increase rapidly in number, and fill up the apex of the follicle (Pl. **20**, fig. 127). But as the ovum approaches maturity, the follicular walls decrease in thickness by absorption into the ovum itself. Most of the cytoplasm about the nuclei in the apex of the follicle is likewise absorbed.

The stalk supporting the ovum is gradually constricted off, the ovum falls into the cavity of the follicle, and is doubtless discharged through the apex of the follicle and through the body walls, as in other species. So far as this individual shows, the egg follicles develop only in the dorsal portion of the body, and the oviducts all open on the dorsal surface.

Habitat.— The single specimen found in these collections was dredged by the Albatross, Aug. 9, 1888, in Lat. 56° 0′ N., and Long. 154° 20′ W. (Sta. 2853, southwest of Kadiak Island, Alaska), at a depth of 159 fms. The bottom of this station was of gray sand, and the temperature 41° F.

64. **Amphiporus californicus**, sp. nov.

Pl. **23**, figs. 172–176.

Body of moderate proportions or somewhat thickened; resembling *A. angulatus* in general shape. Length commonly 10 to 25 mm. or more; width 2 to 3 mm. A small individual was only 6 mm. long and 1 mm. wide.

Color.— Deep reddish orange with an opaque whitish tinge, dark, dull yellowish red, or bright brick red; ventral surface duller and with more whitish. Others are bright and deep orange anteriorly shading to a bright reddish brown in the middle and posterior portions of body; ventral surface bright orange anteriorly becoming duller and more nearly brick red posteriorly. Grayish or dull brownish after preservation. In females with mature ova the olive green color of the ova shows very conspicuously through the body walls.

Ocelli.— A few ocelli of moderate size lie in a single irregular cluster on each side of head; usually only 4 to 8 in number on each side, the anterior one being largest (Pl. 23, fig. 172).

Proboscis.— Of a very pale rose tint from color of distinct pigment granules. Armature of typical form with two pouches of accessory stylets (Pl. 23, fig. 175). Basis of central stylet conical and somewhat bell-shaped, of moderate proportions; central stylet slender and acutely pointed, usually a trifle longer than its basis (Pl. 23, figs. 173–176). Length of basis about .05 to .06 mm., width nearly .03 mm; length of stylet .05 to .065 mm. Proboscis is usually provided with 10 nerves, although 11 or 12 occur in some individuals.

Cephalic glands are well developed. Typical submuscular glands are also present in the brain region, but do not extend far posteriorly.

Alimentary canal.— Intestinal caeca extend far forward above the dorsal ganglia. Stomach and pylorus stretch posteriorly as a slender tube nearly as far as the most anterior sexual glands, where the latter opens into the dorsal wall of the intestinal caecum as usual.

Nephridia.— Nephridial canals extend forward to the brain region, where a rather large canal lies in the lateral angle between dorsal and ventral ganglia and beneath the intestinal caecum on each side. Near posterior end of dorsal ganglion, or a few sections more posteriorly, a single large efferent duct on each side leads past the external side of the lateral nerve to ventro-lateral surface of body. The nephridial tubules extend about twice as far posterior to efferent ducts as anterior to them.

Cerebral sense organs are well developed and greatly elongated; they are situated a short distance in front of brain and are connected with exterior of body on latero-ventral surfaces near tip of head.

Habitat.— Dredged in about 50 fms. off San Pedro, California; also on piles of wharf, San Diego Harbor, California. Not common.

65. Amphiporus macracanthus, sp. nov.

Pl. **24**, fig. 193; Pl. **25**, fig. 200; Text-fig. 55.

This species is in certain respects the most remarkable of the numerous forms of this genus which occur in the region included in this report.

The size of basis of central stylet of proboscis far exceeds that of any other species of the genus, or, indeed, of any other nemertean. The basis alone measures more than a millimeter in length in some specimens, being actually one eighteenth as long as the whole body of the animal when contracted.

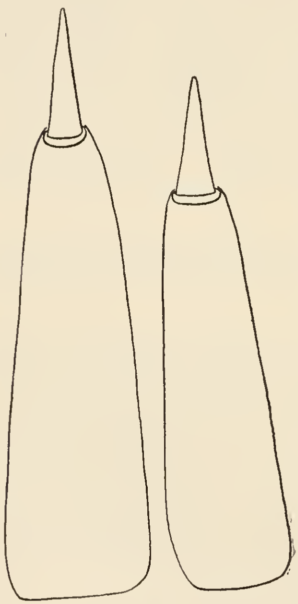

Fig. 55.—*Amphiporus macracanthus.* Outline of central stylets and bases. The one at the left from Wainwright Inlet, Alaska, the other from Cape Smyth, Alaska. × 62.

Body short, thick, rounded, and largest anteriorly when contracted. General shape of preserved specimens much like similar small specimens of *A. angulatus*, but appearance in life unknown.

Length of preserved specimens 14 to 25 mm.

Color in life not recorded, and is not retained in the alcoholic material.

Proboscis. — Of remarkably large size, with a short posterior chamber. It is provided with 10 large nerves. Proboscis sheath extends quite to posterior extremity of body. Armature especially remarkable because of comparatively enormous size of basis of central stylet, which sometimes becomes more than a millimeter in length (Pl. **25**, fig. 200). In a worm measuring 15 mm. after preservation the basis is 0.85 mm. long and 0.25 mm. broad in its widest portion. The basis alone is therefore about one eighteenth

of the whole length of the body of the worm when contracted. When cleared in cedar oil or other clearing agent, the basis is dark in color and distinctly visible to the unaided eye. In form it is somewhat irregularly conical, and is three or four times as long as its greatest width. It is broadest posteriorly, with a rounded or somewhat truncated base, and tapers very gradually and fairly evenly to the attachment of the stylet (Text-fig. 55).

Central stylet very small in proportion to size of basis, being less than one third its length, and sometimes little more than one fourth as long, or about as long as the width of the basis. The stylet is broad and conical, and is blunt rather than sharply pointed (Pl. 24, fig. 193; Pl. 25, fig. 200). There are two pouches of accessory stylets, each containing 1, 2 or 3 short, conical stylets, precisely similar in size and shape to the central stylet. The posterior third or half of basis is dark and granular, while the anterior portion is clear and homogeneous.

Measurements of the armature of 3 specimens are as follows:

Length of basis.	Width of basis.	Length of central stylet.
1. 0.85 mm.	0.25 mm.	0.25 mm.
2. 0.80 mm.	0.20 mm.	0.25 mm.
3. 1.02 mm.	0.30 mm.	0.28 mm.

Nos. 1 and 2 are from Cape Smyth and No. 3 from Wainwright Inlet, Alaska. Comparative sizes of two of these are shown in Text-fig. 55. In one specimen, one of the two lateral pouches contained but a single stylet, which was fully formed, but was no larger than any of the three stylets in the other pouch.

Habitat.— Collected by the Point Barrow Expedition in the Autumn of 1882 in 2½ fms. near Cape Smyth, Alaska. This locality is in Lat. 71° 10′, and is far up in the Arctic Ocean, and near the most northern point of land in Alaska. Collected also at Wainwright Inlet (Lat. 70° 35′), Alaska, in 9 fms., gravel and sandy bottom, by W. H. Dall.

The species resembles *A. arcticus* Punnett (:01, p. 94) in the size of proboscis and number of proboscidial nerves. It is impossible to determine, however, the relationship of the two species because the single specimen from Davis Strait on which Punnett bases his description had the armature of the proboscis dissolved out before the specimen came into his hands.

66. Amphiporus pacificus, sp. nov.

Pl. **17**, figs. 109, 110; Pl. **25**, figs. 202, 203.

Body after preservation short, broad and much flattened, except head, which is rounded and very much narrower than parts following (Pl. **17**, figs. 109, 110). Head provided with shallow lateral transverse grooves, which separate it from body.

Size. — Several specimens from different localities measure, after long preservation, as follows: 12, 25, 35, and 75 mm. in length, and 2, 4, 3, and 5 mm. in width, respectively.

Color. — Some of the preserved specimens still retain a reddish or brownish color on the dorsal surface, but are without color ventrally. Others have lost all trace of the coloring in life.

Ocelli. — A small number of large ocelli lie in an irregular cluster on each side of the narrow head. The number is commonly from 12 to 20 on each side, of which perhaps 4 to 6 are larger than the others and lie in a single longitudinal row on the antero-lateral margin, while the others lie internal and posterior to the marginal row (Pl. **17**, fig. 110; Pl. **25**, figs. 202, 203).

Proboscis. — Proboscis sheath extends quite to posterior end of body. Its walls are thick and are composed of interlaced longitudinal and circular muscular fibers of very large size, instead of being arranged in definite layers as in most species. A somewhat similar condition is found in *A. punctatulus*, *A. occidentalis*, and a few other species of this genus, although it was formerly thought to be characteristic of the genus Drepanophorus alone.

Proboscis is of fairly large size, provided with rather slender central stylet and two pouches of accessory stylets. Basis of central stylet rather slender, conical or somewhat bell-shaped, and is of about the same length as the slender stylet. Each lateral pouch contains usually 3 to 7 slender stylets. There are 14 conspicuous proboscidial nerves.

Rhynchodaeum is separated from mouth opening very near tip of snout, and is surrounded with an unusually strong layer of circular muscles.

Cephalic glands.—Abundant cephalic glands are scattered through the tissues of the head in front of brain. Submuscular glands are wanting, except in a narrow area immediately beneath the lateral margins of body.

Alimentary canal. — Esophageal canal extends from very near tip of snout far beyond the most anterior genital glands before opening into dorsal wall of intestine. Its epithelial lining, however, exhibits the usual differentiation characteristic of the stomach and pylorus posterior to the anterior third. No esophageal caecum is developed.

A broad intestinal caecum extends forward beneath the pylorus about as far as the posterior ends of the nephridia, and somewhat in front of the most anterior genital glands. It sends off the usual short diverticula above the lateral nerves.

Blood vessels. — Cephalic lacunae as in related species; lateral vessels branch considerably and lie closely beside corresponding nephridial tubules, as noted below. Rhynchocoel vessel passes obliquely through wall of proboscis sheath in the vicinity of the nephridiopores.

Nephridia. — The nephridial tubules extend forward to the brain region, where they are sometimes coiled and twisted about the posterior ends of the cerebral sense organs. In one specimen they appear almost as if they were a part of the sense organ itself. Behind the sense organs they become entwined about the lateral blood vessel and its branches. Together they form a crowded mass of tubules, from which the single efferent duct on each side passes to the dorsal side of the lateral nerve, and then makes a sharp bend ventrally to open on the ventro-lateral surface of the body as usual. The nephridial tubules continue but a short distance behind the nephridiopores.

Nerves and sense organs. — Cerebral ganglia very large, but with the usual structure.

Cerebral sense organs remarkably large and highly specialized. They lie beside and behind the brain and in the angle between dorsal and ventral ganglia. They open to the ventro-lateral surfaces of the head by means of broad canals lined with columnar, ciliated epithelium. Posteriorly they become closely connected with the dorsal ganglia from the posterior extremities of which they each receive a large core of fine nerve fibers. Posterior to the termination of the dorsal ganglia the sense organs increase greatly in size by an enormous development of their gland cells. The ciliated, sensory portion of the canal of the sense organ lies farther forward, so that behind the ganglia there is only a large mass of glands

which open into a central lumen connected with the ciliated canal. The tangle of nephridial tubules which lies closely about the posterior ends of the cerebral sense organs is described above.

Reproductive organs. — Several of the specimens sectioned were collected near the end of June, and in these the genital products were fully mature. The spermaries were arranged with great regularity, there being usually two glands on each side between each pair of intestinal lobes. These two spermaries were situated one above the other, but the ducts of both opened to the surface of the body above the lateral nerves. In some cases the ducts were fully formed and were distended with spermatozoa. The ovaries were similarly arranged, although a single ovary often filled the whole space between two neighboring intestinal lobes.

Habitat. — Dredged by the Albatross in the following localities:

Lat. 55° 16′ N., Long. 163° 52′ W. (Sta. 3265). Bering Sea, in 38 fms., black sand.

Lat. 54° 26′ N., Long. 165° 32′ W. (Sta. 3223). Bering Sea, in 56 fms., broken pebbles.

Lat. 48° 13′ N., Long. 123° 11′ W. (Sta. 3443). Off Washington, in 97 fms., green mud and pebbles.

Lat. 37° 08′ N., Long. 122° 28′ W. (Sta. 3148). Off central California, in 47 fms., brown mud.

The known geographical range is therefore from off central California[1] to the Bering Sea, while the range in depth is from 47 to 97 fms. This is one of the most common species of nemertean dredged by the Albatross in the off shore waters of the Pacific Ocean and Bering Sea.

The general color of body, number of ocelli, number of proboscidial nerves, position of cerebral sense organs are characters in which this species agrees with *A. rubellus*, but the presence of a highly developed esophageal caecum in the latter will readily distinguish the two species.

A single specimen probably belonging to the above species was dredged in 50 fms., green muddy bottom, at a point off the coast of central California (Sta. 3165, Lat. 37° 59′ N., Long. 123° 08′ W.). This specimen was 60 mm. long, 6 mm. wide and 2½ to 3 mm. in thickness; the body was much flattened throughout and compara-

[1] Possibly from the Gulf of California. See p. 271.

tively slender in its anterior and posterior thirds, but was broad in its middle portions. Head rather slender, with shallow transverse lateral grooves.

Proboscis sheath thick, of interlaced longitudinal and circular fibers, extending to posterior extremity of body. Proboscis missing. Cephalic glands well developed, situated mostly in ventral half of head. Submuscular glands limited to narrow area just beneath lateral margins of body.

Nephridial tubules voluminous, as in *A. pacificus*, except that efferent ducts were very long and extended far posteriorly beneath the lateral nerves before opening on ventral surface of body.

Numerous slender diverticula of the intestinal caecum extend forward to nephridiopores; pylorus opens into intestine far back of anterior sexual glands.

A moderate amount of parenchyma lies in the esophageal region, but becomes increased to an unusual degree in intestinal region. Brain and cerebral sense organs as above.

Another specimen from which the proboscis was likewise missing, but which was indistinguishable from *A. pacificus* in other features of internal anatomy and in external characters after preservation was dredged in 9 fms. in the Gulf of California by the Albatross (sta. 2826, Lat. 24° 12′ N., Long. 109° 55′ W.). The water temperature here is about 73° F. in April and rises considerably higher in midsummer. It seems reasonable on this account to admit the possibility that this specimen actually belongs to a species distinct from *A. pacificus* found in the colder waters off the coast of California and in Bering Sea, and that living individuals or the structure of the proboscis would reveal marked specific differences.

67. **Amphiporus occidentalis**, sp. nov.

Pl. 20, fig. 121.

The two preserved specimens are both about 25 mm. in length and 3 mm. wide. Body broadest posteriorly, only slightly flattened, much as in *A. angulatus*; head separated from body by transverse grooves.

Color. — One of the specimens was thickly mottled and blotched with dark reddish brown on a pale ground color throughout whole

of dorsal surface. This color remained even after imbedding in paraffin. Ventral surface without color. A specimen from another locality showed no indication of the original coloring.

Ocelli. — Numerous large ocelli lie on each side of head, but their definite arrangement could not be made out.

Proboscis sheath of strong, interlaced circular and longitudinal muscles as commonly occurs in DREPANOPHORUS, although such a condition is very rare in the present genus. *Proboscis* not preserved in either of the specimens.

Cephalic glands fairly well developed. Submuscular glands practically wanting.

Basement layer of body walls well developed, in intestinal region as thick as circular muscles and integument combined; but little body parenchyma is present.

Alimentary canal. — The peculiarities of the various portions of the digestive canal will readily distinguish the present species from most other described forms of the genus. As shown in Pl. **20**, fig. 121, there is a caecal appendage to the esophagus and one to the stomach in addition to the highly developed intestinal caecum. Esophagus separates from rhynchodaeum near the tip of snout, but remains of small diameter until posterior to brain. Here it enlarges and is lined with a more columnar epithelium. A short distance back of brain the esophagus branches into two portions, one of which lies directly ventral to the other. The dorsal portion passes by a narrow opening into the long stomach, while the ventral canal retains the characteristic lining of the esophagus, but ends blindly posteriorly. Such an esophageal caecum, as it may be called, has been described and figured by Joubin (**'90**, p. 564) for *A. marmoratus*, and occurs also in *A. arcticus*, Punnett (**:01**, p. 94). It is found in two other forms from the Pacific coast, as mentioned below. In the present species the esophageal caecum extends backward nearly to the most anterior sexual glands. In one of the specimens it was still further complicated by again bending forward beneath its posterior portions as a rather narrow appendix (Pl. **20**, fig. 121, *app*). The cells of the appendix are somewhat modified, are more glandular and stain more deeply with haematoxylin than do those of the esophageal caecum proper. This caecum extends posteriorly considerably beyond the anterior diverticula of the intestinal caecum (Pl. **20**, fig. 121), so that a section through the

body in the region of the appendix of the caecum shows four distinct portions of the alimentary canal. In the ventral median line is the narrow appendix (*app*), directly above it the esophageal caecum (*ec*), above and lateral to the caecum are several sections of the diverticula of the intestinal caecum (*ic′*), and finally in the median line directly beneath the proboscis sheath is the narrow stomach (*st*). In the specimen which has no such appendix as that described there are, of course, but three divisions of the digestive tract in a similar region.

An approach to this condition is met with in *A. bimaculatus* (p. 243), where a conspicuous esophageal caecum also occurs beneath the stomach, but is much less complicated than in the present species. *A. rubellus* is a third form possessing such an esophageal caecum, which in this case, however, does not extend back so far as the anterior end of intestinal caeca.

The stomach after originating from the dorsal wall of the esophagus immediately sends off a short and broad cardiac caecum (Pl. 20, fig. 121, *cac*) directly forwards toward the brain. The extent and form of this cardiac caecum depend largely on the state of contraction of the parts of the body adjacent. When the body is well extended this caecum probably disappears for the most part, and is directly continuous with the stomach. The posterior portions of the stomach are continued into a long and slender pylorus, which does not open into dorsal wall of intestine until far behind the most anterior sexual glands. In these two specimens, which are much contracted, the opening of the pylorus into intestine is actually farther posterior to the anterior sexual glands than are these from the tip of snout. I know of no other species of the genus where the pylorus is so extensive as in the present form.

Correlated with the great length of pylorus occurs a very extensive intestinal caecum (fig. 121, *ic*), which extends forward beneath the pylorus and stomach as usual, sending off numerous branching, and sometimes anastomosing, diverticula beside and above the stomach. These diverticula extend forward to within a short distance of the opening of esophagus into stomach and well in front of anterior sexual glands. They are very irregularly branched and narrow anteriorly, but are reduced to short lobes near the posterior portions of the pylorus, where the median, broad, branched caecum is situated. The unbranched caecum sends forward the two long

appendages from which the diverticula above described originate. The intestine proper (mid gut) and its lateral diverticula are as in related species.

Nephridia are situated immediately behind the brain and are limited to a comparatively short distance in the esophageal region. A single pair of efferent ducts opens on the ventro-lateral surfaces of the body a short distance behind the brain.

Cerebral sense organs unusually voluminous, situated beside brain and extending back as large lobes posterior to dorsal ganglia.

Reproductive organs. — Sexual products nearly mature in a specimen collected in August. Sexual glands situated beneath muscular layers of body walls throughout nearly the whole circumference of body, but opening on dorso-lateral surfaces of body almost without exception.

Habitat. — But two specimens of this species were contained in the collections at hand. Both were dredged by the Albatross; the one from 40 fms. off Washington in 1888 (Sta. 2865, Lat. 48° 12′ N., Long. 122° 49′ W.) on pebbly bottom. The other was taken three years later near the same locality (Sta. 3443, Lat. 48° 13′ N., Long. 123° 11′ W.) in 97 fms., green mud and pebbles.

This species is apparently closely related to *A. rubellus* from off San Pedro, California, but presents several points of difference, as indicated (p. 276). Both species are remarkable in the possession of a conspicuous esophageal caecum, but this peculiarity is shared with three other species of the genus, *viz.*, *A. bimaculatus* (p. 241) from nearly the same region, *A. marmoratus* from Europe (Joubin, '**90**, p. 564), and *A. arcticus* from Davis Strait (Punnett, :**01**, p. 94). Unfortunately the armature of the proboscis has been described in but two of these five forms, so that their specific relationship remains uncertain.

As stated above, however, the peculiarities of the various portions of the digestive tract, with esophageal and cardiac, as well as intestinal caeca, are sufficiently marked to distinguish the present species from any of these others.

68. **Amphiporus rubellus**, sp. nov.

Pl. **1**, figs. 11, 12.

Body short, thick and stout; in life often broader and thicker

posteriorly than near anterior end (Pl. 1, figs. 11, 12); much like *A. angulatus* in shape. Length 25 mm. or more, width at least 3 mm. After preservation body is usually swollen and truncate anteriorly; smaller and more flattened in intestinal region.

Color. — Deep flesh color, pale orange, or pale red; much paler and usually grayish beneath (Pl. 1, figs. 11, 12).

Ocelli. — Two groups of ocelli on each side, situated deep among the cephalic tissues and arranged such as in *A. angulatus*; usually 6 to 10 moderately large ocelli in each group.

Proboscis of very large size, provided with 14 nerves; armature was unfortunately destroyed by preserving fluid before examination.

Cephalic glands voluminous. A few submuscular glands lie near lateral margins of body in brain region, but do not extend far posteriorly.

Basement layer very thick. A large amount of parenchyma lies between the bundles of longitudinal muscles and separates the body organs widely. Few other species have a greater development of the body parenchyma. Peculiar cup-shaped glands are present in basal portion of integument, as in *Drepanophorus ritteri* (p. 285).

Alimentary canal. — Esophagus presents two distinct chambers well differentiated anatomically and histologically, and situated one above the other, much as is described above for *A. occidentalis* (p. 272). The ventral branch — esophageal caecum — is directly continuous with esophagus, and is lined with typical esophageal epithelium. It continues as a narrow tube as far as the posterior end of the nephridial region, where it ends blindly. A similar structure occurs also in *A. bimaculatus*, *A. marmoratus*, and *A. arcticus* (see p. 274). The broad dorsal chamber, or stomach, opens from the dorsal wall of esophagus a short distance behind the brain, and passes backward directly beneath the proboscis sheath and above the esophageal caecum. Posterior to the end of this latter, the stomach continues above and between the intestinal caeca as a much narrower tube, or pylorus, which much farther back opens into dorsal wall of intestine as usual. The stomach is lined with comparatively short, ciliated and glandular cells, which are characteristic of this organ in other species of the genus.

The most anterior diverticula of the intestinal caecum do not extend forward quite so far as to reach the posterior end of the esophageal caecum. In this respect the present species differs from

A. occidentalis, where the diverticula of the intestinal caecum extend far in front of posterior end of esophageal caecum. They are mostly narrow and much branched, and extend dorsally above lateral nerves as usual.

Comparative lengths of various portions of alimentary canal in one individual are as follows: —

Posterior border of dorsal ganglia to posterior end of opening of esophagus into stomach . . .	29	sections.
From this point to end of esophageal caecum . .	24	"
From end of esophageal caecum to end of pylorus	73	"
Making length of stomach and pylorus . . .	97	"

The sections in this instance were .015 mm. in thickness.

The intestine (mid gut) posteriorly has a comparatively narrow lumen with peculiarly slender diverticula, separated from each other and from the body walls by a very large amount of parenchyma.

Nephridia.— Nephridial tubules extend forward to brain region, and are limited to the anterior portion of the esophageal region. A single pair of large efferent ducts passes to ventro-lateral surfaces of body as usual. In each of two specimens sectioned a diverticulum of each efferent duct extended for about a dozen sections posteriorly in the longitudinal muscular layer.

Cerebral sense organs.— These are remarkably highly developed and are situated beside and behind the dorsal ganglia. The canal connecting each with the exterior passes forward beside the dorsal brain lobes, and thence in front of brain to open into distinct lateral furrows well anterior to brain region. The sense organs reach their maximum development immediately behind dorsal ganglia, and are here but a trifle smaller than the latter.

The lateral blood lacunae lie immediately behind and beside the sense organs, but do not surround them. A section through the sense organs somewhat resembles superficially a similar section through a Heteronemertean.

Habitat.— Piles of wharf, San Diego, California; dredged in 20 to 50 fms. off San Pedro, California. Not uncommon.

This species is evidently closely related with *A. occidentalis* (p. 271) which has been dredged off Washington, but differs in having a great development of the body parenchyma, in the comparative length of the intestinal caeca, and will probably be found to exhibit differences in structure and armature of proboscis.

The number of proboscidial nerves (14) will distinguish the present species from *A. arcticus*, with 10 such nerves, and *A. marmoratus*, with 16, both of which forms also possess an esophageal caecum. Its relationship to *A. occidentalis* is noted above. The only other known species of the genus with such a diverticulum to the esophagus is *A. bimaculatus*, and this can be easily distinguished by the presence of two conspicuous black spots on the head.

69. Amphiporus flavescens, sp. nov.

Pl. **2**, fig. 22; Pl. **16**, figs. 97, 98; Pl. **23**, figs. 162–171.

Body of moderate proportions for genus, rather small, head slightly broader than body in some stages of contraction.

Size.— Length usually 12 to 20 mm.; width 0.5 to 1 mm. Some specimens obtained were no more than 6 to 8 mm. in length, while a few larger individuals were 25 mm. or more.

Color.— Very variable, usually whitish, pale flesh color, or pale yellow (Pl. **2**, fig. 22). Some individuals are opaque white with pale yellow intestinal lobes; others are translucent, whitish or pale ocher anteriorly, fading to whitish toward posterior end of body; still others shade from pale orange to ocher, with orange intestinal lobes. Females with ripe ova incline to yellow, while males are more of a grayish white; head and anterior esophageal region of both sexes are commonly flesh colored or pale orange. Brain usually yellowish, intestinal lobes of all shades of pale yellow, gray, and pale brown. Color quickly lost after preservation.

Ocelli.— Number and arrangement of ocelli present considerable variation according not only to size of worm, but to individual peculiarities (Pl. **16**, fig. 97; Pl. **23**, figs. 162–163). There are commonly from 12 to 25 ocelli on each side of head, and these are arranged in two groups on each side. The anterior groups lie on the antero-lateral margins, and these ocelli are often arranged in a single irregular row of 6 to 12 on each side. The posterior groups are still more irregularly arranged, and extend from the internal border of posterior ends of anterior groups backward to about the anterior border of the brain. The cluster of 6 to 12 ocelli in each of these groups usually appears to extend laterally as well as backward (Pl. **16**, fig. 97), but by the increase in the number of the ocelli and the

posterior extension of the anterior marginal groups, there sometimes appears a posterior group which apparently extends posteriorly and inwardly (Pl. **23**, fig. 162) instead of laterally as in the individuals with fewer ocelli (fig. 163). Sometimes, also, the arrangement into definite groups is not apparent, and the ocelli appear to be scattered irregularly along the lateral margins, with irregular longitudinal clusters nearer the median line.

Proboscis.— Proboscis sheath extends to posterior end of body. Proboscis of large size, and about as long as the entire worm; whitish, pale yellowish or slightly rosy in color. Usually provided with 10 nerves, although 11 are present occasionally. Central stylet slender and acutely pointed. Basis conical or bell-shaped; usually much wider at its posterior border than more anteriorly (Pl. **16**, fig. 98; Pl. **23**, figs. 165–168, 170, 171). As a rule, the smaller individuals with fewer ocelli have the basis much more widened and bell-shaped posteriorly than do the larger individuals with more numerous ocelli. Thus the proboscis of the individual figured on Pl. **16**, fig. 98, has a wide, bell-shaped basis, while a larger individual with more than double the number of ocelli (Pl. **23**, fig. 165) has a more slender, conical basis.

Basis is of just about same length as the slender central stylet, or a little shorter, and is from one half to three fourths as wide posteriorly as its length. Length of largest basis measured was fully double that of smallest; measurements of a large number of bases ranging from .044 to .09 mm. in length and .025 to .042 mm. in width.

These variations in the stylet apparatus of proboscis, when taken with the decided variation in color of body and number of ocelli, suggest that several species may be represented, and this was my impression for a long time. Careful comparison of a large number of individuals, however, convinced me that it was absolutely impossible to draw a sharp line of demarcation between any two groups of individuals that would agree both in regard to the ocelli and the proboscis armature. It seems necessary, therefore, to unite all these forms into a single, variable species.

Proboscis sheath corpuscles are conspicuous under high magnification because of their pale yellowish color.

Cephalic glands well developed; submuscular glands practically wanting.

Parenchyma. — When proboscis is extruded, a moderate amount of parenchyma lies above the proboscis sheath, but is hardly evident when proboscis is in place and its sheath much distended.

Alimentary canal. — Much branched intestinal caeca extend forward to brain region, where a single pair of diverticula either passes forward above dorsal ganglia or abuts closely against their posterior faces according to state of contraction of cephalic tissues. Pylorus continues posteriorly for a considerable distance beyond the most anterior sexual glands, both in males and females, before opening into dorsal wall of intestine.

Nephridia. — Nephridial tubules extend forward as far as the brain, but do not reach far back into esophageal region. A single pair of efferent ducts passes to ventro-lateral surfaces of body a few sections behind brain, and near anterior portion of nephridial region.

Cerebral sense organs. — These are voluminous and much elongated. They are situated mainly in front of brain, although their posterior extremities extend posteriorly beneath the ventral ganglia. In the living worm they appear to be from one half to two thirds the size of the dorsal ganglia.

Reproductive organs. — Sexual products are mature in August. Ducts of genital glands in both sexes open above lateral nerves. When spermaries lie near ventral surface of body their ducts pass dorsally to open on lateral margins of body immediately above lateral nerves, while those glands which are situated in dorsal portion of body open more dorsally than the others, but yet near the lateral margins of body.

Habitat. — Common on piles at Monterey, San Pedro. and San Diego, California; also under stones and among algae in same localities.

70. **Amphiporus leptacanthus**, sp. nov.

Pl. 22, fig. 161.

Body of moderate proportions for genus; rather small; specimens obtained measuring about 15 mm. in length and 1.5 mm. in width.

Color. — Whitish with tinge of yellow or flesh color anteriorly, buff or light brown in intestinal region.

Ocelli. — Usually 16 to 20 or more ocelli of medium size on each

antero-lateral margin of head. These are usually arranged in a single elongated and very irregular cluster on each side.

Proboscis. — Proboscis sheath extends to end of body. Proboscis of moderate proportions, with remarkably slender basis of central stylet. Few other species of the genus possess so slender a stylet basis, which is four or five times as long as its diameter (Pl. **22**, fig. 161). Basis is of about the same diameter throughout, and is no wider at its posterior end than anteriorly. It measures about 0.1 mm. in length and .024 mm. in diameter. Comparative length of central stylet is not known, as the specimens first came into my hands after having been preserved for a few days in formalin, by which the stylet had been partially dissolved.

Internal anatomy. — Characterized by an unusual thickness of the basement membrane and a correspondingly large amount of parenchyma separating the organs of the body. In this parenchyma the nephridial tubules appear as very distinct, branching canals. In the head the muscular fibers and other tissues are well separated by this same parenchyma.

Intestinal caeca much reduced, extending forward but a very short distance.

Cerebral sense organs remarkably small, not much larger in section than one of the larger ocelli; situated far in front of brain.

In the single specimen available for sectioning, the brain region was contracted to such an extent that the brain itself was drawn backward beyond the anterior portion of the lateral nerves, so that both brain and lateral nerves appeared in the same section.

Habitat. — Dredged in about 50 fms. off Pott's Valley, Santa Catalina Island, California. Not common.

The single irregular cluster of ocelli on each side of head and the slenderness of the stylet basis will serve to distinguish this from any of the other described species of the genus from this region.

71. **Amphiporus fulvus**, sp. nov.

Pl. **2**, fig. 23.

Body decidedly slender, rounded, of small size; length 15 to 25 mm. or more, width rather less than 1 mm. Head slender; lateral oblique grooves as in related species.

Color. — Pale brownish anteriorly, becoming deep brown in intestinal region, much paler beneath; head deep flesh color, inclining to pale brown (Pl. 2, fig. 23). Color of body consists of innumerable minute dark brown dots scattered thickly over the deep flesh colored ground color. Intestinal caeca reach forward to brain as dark, lobulated organs.

After preservation dorsal surface retains a pale brownish color.

Ocelli. — Usually 25 or more ocelli of small size are situated on each side of head. Sometimes they appear to be arranged in anterior and posterior clusters, but are usually irregularly scattered along antero-lateral margins of head as far back as the brain. The ocelli which are situated the most posteriorly are farthest removed from margins of head.

Proboscis. — Proboscis sheath extends practically to posterior end of body. Proboscis of moderate size, pale pinkish in color. Central stylet very slender and acutely pointed; basis bell-shaped, rounded posteriorly, and about three fourths as long as stylet. Each of the two lateral pouches contains usually two or three very slender stylets, of size and shape like central stylet. Basis averages about .045 mm. in length and .025 to .030 mm. in width; stylets are about .06 mm. long.

Internal organization. — Cephalic glands well developed, but submuscular glands are practically wanting. Pylorus passes back for a long distance before opening into dorsal wall of the broad unpaired intestinal caecum lying beneath it. This caecum sends off numerous slender, paired diverticula anteriorly and dorsally above the lateral nerves. The most anterior pair of these diverticula extend as far forward as the posterior ends of the dorsal ganglia.

Cerebral sense organs voluminous, situated almost immediately in front of brain. Ducts pass anteriorly to latero-ventral surfaces of head as in related species.

Nephridia are situated immediately posterior to brain. Rather large tubules lie beside and internal to the lateral nerves and open by means of a single pair of efferent ducts to ventro-lateral margins of body a short distance behind brain.

Habitat. — Piles of wharf, San Pedro Harbor, California. Not common. Dredged off Santa Catalina Island in 50 fms.

72. Amphiporus brunneus Griffin.

Ann. New York Acad. Sci., **11**, p. 212, 1898.

This species is known only from Griffin's description ('**98**, p. 212), which reads substantially as follows: —

Length in alcohol 3.3 cm.; width 5 mm. Color in life dark brown or smoky black dorsally; greenish or yellowish white ventrally, with a pale, angular spot on each side of neck.

Cephalic glands moderately developed; cerebral sense organs considerably in front of brain. Intestinal caeca reach nearly to brain region. Basis of central stylet long; two pouches of accessory stylets with 2 (or 3 ?) stylets each.

Habitat.— Port Townsend, Puget Sound.

In some respects this description agrees with the characters of *Paranemertes peregrina*, which is common in Puget Sound, but on the following page (p. 213) the species is represented as bearing "a more or less general resemblance to *A. angulatus*." There can hardly be said to be the slightest resemblance between *P. peregrina* and *A. angulatus*, so that even with Griffin's notes and material at hand it is impossible to determine to which, if any, of the described species this *A. brunneus* belongs. It must therefore stand as valid for the present.

73. Amphiporus drepanophoroides Griffin.

Ann. New York Acad. Sci., **11**, p. 212, 1898.

This species is known only from Griffin's description ('**98**, p. 212). Griffin's account is substantially as follows: —

Length 4–5 cm. or less; form short and stout; color red above, white beneath; eyes numerous, in rows along antero-lateral margins of head. Cephalic and submuscular glands prominent. Cerebral sense organs large, situated beside brain and extending posteriorly behind dorsal ganglia; canals open in front of ventral commissure.

Differs from most other species of genus in smallness of rhynchocoel, which is enclosed in a thick muscular sheath in which longitudinal and circular muscles are interwoven. No intestinal caecum; circular muscle-layer quite thick.

Habitat not given, but probably Puget Sound.

No specimens answering to the above description have come into my hands, nor were any specimens or slides showing such anatomical peculiarities contained in Griffin's collection after it was turned over to me. The absence of the intestinal caecum is especially remarkable.

Drepanophorus Hubrecht.

Aanteekeningen over die Anatomie . . . . Nemertinen. Utrecht, 1874.

Body usually comparatively short, broad and much flattened, not very contractile, and never coiled or much twisted. Mouth and proboscis opening slightly separated. Proboscis sheath possesses metamerically arranged lateral diverticula, commonly spreading out between the intestinal lobes as thin-walled sacs and connected with the rhynchocoel by comparatively narrow openings. Proboscis armed with numerous, commonly 20 or more, very small stylets situated on a large, sickle-shaped basis, and with numerous pouches of reserve stylets.

Cerebral sense organs very large, situated beside or immediately behind the brain. Ocelli numerous and of very large size. Lateral nerves situated ventrally, beneath intestinal diverticula. Brain and cephalic nerves very highly developed. Neurochord cells present.

These worms are seldom more than 5 to 10 cm. in length, although a few forms are among the largest of the Hoplonemerteans. All are capable of swimming.

But a single species of this genus is represented among the collections at hand.

74. Drepanophorus ritteri, sp. nov.

Pl. **17**, fig. 106; Pl. **20**, fig. 128; Pl. **24**, figs. 179–181; Text-fig. 22.

Body comparatively short, flattened, or somewhat rounded on dorsal surface, and broad, as in typical species of the genus. Head small, distinctly demarcated from body by a pair of conspicuous lateral grooves (Pl. **24**, fig. 179). Each groove is traversed by numerous transverse lines of paler color, so that it resembles a fluted collar, very much as Joubin has figured for *Amphiporus marmora-*

tus ('**93**, Pl. 2, fig. 45), and as has been described for other species of DREPANOPHORUS.

Proboscis pore situated ventrally a little behind end of snout; mouth opening when body is contracted a short distance behind proboscis pore (Pl. **24**, fig. 180).

Length of body 5–10 cm. or more; width, 4–5 mm.

Color. — Dorsal surface of body dull reddish or orange, thickly covered with very fine brownish dots of such great number and minute size as to give the impression of a general reddish brown tinge; deeper red in the brain region because of the pink color of the brain. Head is somewhat darker in color than rest of body and has on its dorsal surface two indefinite darker brown patches.

Ventral surface pale flesh color with a tinge of orange; intestinal lobes commonly impart a tinge of buff.

Ocelli. — Upwards of 25–35 large black ocelli occupy each side of the head between brain and tip of snout, and are conspicuous from the dorsal surface. The ocelli in each cluster appear to be scattered irregularly, and somewhat removed from the lateral margins posteriorly (Pl. **17**, fig. 106; Pl. **24**, figs. 179–181; Text-fig. 22). In addition to these ocelli, which are visible from the dorsal surface, a single row of 25–30 large ocelli is situated on each side much nearer the ventral surface, and these are seen distinctly only from below (Pl. **24**, fig. 180). They lie ventrally near the lateral margins of the snout, and are placed side by side and almost in contact. The single row becomes more irregular and often divided into two posteriorly (Pl. **24**, figs. 180, 181; Text-fig. 22). The pigment cups of nearly all of these ocelli are directed toward the lateral margins.

Proboscis. — In the single individual of this species which came into my hands alive the proboscis had unfortunately been discharged and lost before the worm was found.

Proboscis sheath with interspersed longitudinal and circular muscular fibers as usual. It extends to posterior extremity of body, and is provided with diverticula as in related species. These diverticula are of moderate proportions or rather slender, and extend laterally above the lateral nerves where they expand into thin-walled saccules. Rhynchocoel vessel passes outside proboscis sheath in the anterior third of esophageal region. A single specimen (probably, but not certainly, belonging to this species) collected by the Albatross (definite locality unknown) had 32 proboscidial nerves.

Integument and body walls. — Muscular layers as usual; basement layer well developed; parenchyma of body cavity of moderate extent. Situated just outside the basement layer of the body walls, and at the very base of the integument, is a continuous layer of peculiar cup-shaped structures which are evidently the bases of peculiar integumental glands, and these extend throughout the whole length of the body. They are packed as closely together as possible, and form the same continuous layer from tip of snout to posterior end of body. In sections stained with haematoxylin and orange, they are intensely deep blue, and much darker than nuclei or any of the ordinary glandular secretions. Seen in section each cup-shaped body is seen to rest on the underlying basement layer (Pl. **20**, fig. 128). Each one is U-shaped in section, the free ends lying among the granular integumental cells above. A small nucleus usually appears in some portion of the cup. Seen in a section parallel to the surface of the body, the cups are circular or irregular in outline and packed together as closely as possible. They are evidently glandular structures of a peculiar nature, for similar glands are found in *Amphiporus rubellus* and certain other species, but are much less highly developed.

Cephalic glands are but little developed, although a conspicuous pit is present on the tip of the snout into which the ducts from the glands open.

Alimentary canal. — The digestive system presents few deviations from that of typical species of the genus. The mouth is situated well back from the tip of the snout, and when proboscis is everted in certain states of contraction opens separately from proboscis pore. The esophagus is slender as far back as the brain, posterior to which it enlarges greatly and enters the stomach, which has its epithelium thrown up into large, irregular, longitudinal folds. The intestinal caeca do not extend far forward — not so far as the nephridiopores. The wide stomach passes into a narrow posterior chamber (pylorus), which extends back far beyond the most anterior sexual glands before opening into the intestine. The intestinal caecum which lies beneath the pylorus is itself narrow, but it sends off a few pairs of larger diverticula which pass anteriorly in the body parenchyma along the internal faces of the lateral nerves. These diverticula also pass above and sometimes external to the lateral nerves, — that is, nearer the lateral margins. Intestine opens on dorsal side of posterior extremity of body.

A pair of peculiar vesicles lined with highly columnar epithelium lies in front of the brain and beside the esophagus. Their precise nature and function have not been determined.

Blood and nephridial systems. — The cephalic blood lacunae conform to the usual type for the genus. The dorsal vessel passes inside the muscular walls of the proboscis sheath at the posterior end of the brain region, and again leaves the rhynchocoel near the anterior end of the intestinal caeca, or some distance behind the nephridiopores. Numerous large blood lacunae lie in the body parenchyma above and external to the lateral nerves in the posterior esophageal region.

The nephridial tubules extend forward nearly to the brain, and ramify in the parenchyma above the lateral nerves. Their branches are remarkably large and numerous. They extend backward somewhat beyond the anterior ends of the intestinal caeca. Near their middle portions a pair of large efferent ducts passes immediately above the lateral nerves and then bends sharply toward the ventral surface. After passing below the level of the lateral nerves, these ducts bend farther toward the median line and pass obliquely through the muscles to open on the ventral surface of the body. The nephridiopores are thus situated even nearer the median line than are the lateral nerves.

Nervous system and sense organs.— Brain is of the usual massive form with neurochord cells and very large dorsal and ventral commissures. Nerves are also very highly developed.

The cerebral sense organs are situated beside the brain, and have nearly the same extent as the dorsal ganglia (Pl. **24**, fig. 181). The short and broad canal on each side opens to the surface on the ventro-lateral margin in the region of the dorsal commissure, while the posterior end of the sense organ lies beside the posterior end of the dorsal ganglion. From the posterior end of this ganglion a large nerve enters the sense organ.

Reproductive organs.— As stated above, the most anterior sexual glands are situated anterior to the opening of the pylorus into the intestine. The more anterior sexual glands lie external to the lateral nerves, while farther back they lie both external to the nerves and nearer the median line. In a specimen collected in July the ova were nearly mature, and large oviducts were formed in the body walls as far as the basement layer. In all the cases observed the oviducts passed toward the ventral surface.

Habitat.— Dredged in about 50 fms. between San Pedro and Santa Catalina Island, California, associated with *Taeniosoma punnetti* and *Carinella albocincta.* Not common. One specimen was dredged by the Albatross off southern California (Sta. 2946, Lat. 33° 58′ N., Long. 119° 30′ W.) at a depth of 150 fms. Bottom of coarse gray sand ; temperature 56° F.

Tetrastemma Ehrenberg.

Symbolae Physicae, Berlin, 1831.

This genus includes a group of very small, slender worms, seldom more than 20 to 30 mm. long, with slightly flattened body, and usually with four well developed ocelli, which form a quadrangle on the head. In a few species (cf. *T. aberrans*) these ocelli are each replaced by a group of two or three smaller ones, and in other species ocelli are wanting entirely. The anatomical structures are very similar to those of Amphiporus, and the distinctions between the two genera are not clearly defined. Mouth and proboscis open together. Cerebral sense organs lie close in front of brain. Proboscis sheath extends to posterior end of body and is without lateral diverticula ; proboscis is well developed, armed with central stylet and usually two pouches of accessory stylets ; it is usually provided with ten nerves.

Ten species of this common and widely distributed genus have now been collected on the Pacific coast of North America, and are enumerated below. Of these ten species only one (*T. dorsale*) has been recorded from other parts of the world. One form (*T. albidum*) is here described as new.

75. Tetrastemma signifer Coe.

Harriman Alaska Expedition, **11**, p. 156, Pl. 14, figs. 9–11 ; Pl. 21, figs. 10–12, 1904.

Pl. **2**, fig. 24 ; Text-figs. 21, 56.

This pretty little species with its dainty cephalic marking exhibits the following peculiarities of appearance and structure : —

Body rather slender, rounded throughout, not very changeable in

shape; head of moderate size, somewhat narrower than body, marked off from parts immediately following by rather conspicuous oblique lateral grooves; with a second pair of similar oblique grooves lying farther forward on head.

Size. — Length 15–25 mm., width less than 1 mm.

Color. — General color of body deep reddish brown or purplish, except head, which is white, with characteristic dorsal marking (Pl. 2, fig. 24). Ventral of same color as dorsal surface, but of a duller tone, and often much paler in median line. Head pure white both above and below with dark brown marking resembling a wreath in heraldry on upper surface. Wreath has a transverse, posterior or basal portion from which two semicircular branches pass anteriorly, but do not usually join (Pl. 2, fig. 24; Text-fig. 21). A fourth portion of figure passes forward in median line from basal portion to anterior ends of semicircular lateral bands, but does not usually join them. All parts of marking have irregular edges so that the wreath-like effect is made still more striking. The general effect is often that of an open wreath with vertical cross-bar and substantial base, the whole figure appearing upon a white field. Wreath not always open, for one or both of its anterior ends may join the anterior end of vertical bar. Whole figure surrounded by white, continuous with that of ventral surface of head and separated from reddish brown of esophageal region by a fairly wide band of the same color (Pl. 2, fig. 24). Color of body and shape of marking conspicuous after preservation, and even after imbedding in paraffin.

Blood vessels red in color, due to color of oval or rounded discoid corpuscles.

Ocelli.— Four ocelli of rather large size are arranged beside the cephalic wreath nearly in the form of a square (Text-fig. 21). Ocelli lie deep in tissues of head, and thus occupy a somewhat variable position as regards the marking.

Proboscis of moderate size; whitish or pale flesh color; provided with ten distinct nerves. Central stylet slender and acutely pointed; basis about one and one half times as long as stylet, rounded posteriorly, opaque and granular in posterior third (Text-fig. 56).

Pigment of body resides at base of integument.

Alimentary canal.— Intestinal caeca slender, extending forward to abut against posterior faces of dorsal brain lobes.

Nephridia remarkably limited in extent, but consist of unusually large tubules situated above lateral nerves, beside stomach, and immediately behind brain. Two large canals often occur on each side, one of which lies above and the other below the slender intestinal caecum. After a very short extent, they unite to form a remarkably large efferent duct on each side, which passes above lateral nerves to open on, or immediately below, the lateral margin of body.

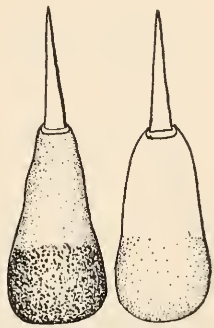

FIG. 56. — *Tetrastemma signifer*. Central stylets and bases from two individuals.

Cerebral sense organs voluminous and highly specialized, situated immediately in front of brain.

Habitat.— This species has been collected on piles of wharf at San Pedro, California, and on kelp 'hold-fasts' in 3–6 fms. outside same harbor, but is not common. Sexual products are mature in August.

76. Tetrastemma nigrifrons Coe.

Harriman Alaska Expedition, **11**, p. 159; Pl. 15, fig. 7; Pl. 16, figs. 6–9; Pl. 17, fig. 1; Pl. 20, fig. 16; Pl. 21, figs. 15–23, 1904.

Pl. **2**, fig. 26; Pl. **18**, figs. 111–115; Text-figs. 57–59.

Different individuals of this species are of extremely varied colors even when collected in the same locality, and present a number of characters diverging from those of other described species of the genus. The more important peculiarities of external appearance and internal structure are as follows: —

Body of moderate proportions, or rather slender for genus, rounded throughout; head more variable in size and shape than in many related species; provided with two pairs of lateral, oblique furrows of more than ordinary distinctness, anterior pair lying between anterior and posterior pairs of ocelli, and the posterior pair situated just behind the posterior pair of ocelli, serving to mark off the head from the body (Pl. **18**, figs. 111–113). Each of the anterior furrows extends on dorsal surface from lateral border obliquely

backward toward the median line, but fades out gradually before meeting its fellow; on the ventral side the furrows extend obliquely forward and join in the median line not far behind the rhynchodaeum opening (Pl. 18, fig. 112). The posterior furrows are much more conspicuous, often forming a distinct fluted collar (Pl. 18, fig. 111).

Color.— Variations in color and markings so striking that several species would appear to be represented by individuals which actually present all degrees of intergradation. All color varieties agree in internal organization, and also are similar in having a whitish or pale yellowish head provided with a dark dorsal marking of variable size and shape (Pl. 2, fig. 26; Pl. 18, figs. 111, 113); ventral side of head whitish or very pale gray in all varieties. Blood corpuscles deep red in color. The three more distinct color varieties are as follows: —

Variety *purpureum* (Pl. 2, fig. 26). Head opaque white, with large, shield-like dark brown dorsal marking, rounded in front and deeply bilobed in median line; white color of head extends a short distance back of marking, or as far as the posterior oblique furrows, where it abruptly changes to a deep, rich purple, which color extends to posterior end of body. Ventral surface of same general color as the back, but somewhat paler and with a more reddish tinge; often with a much paler median band anteriorly. Ventral side of head whitish, separated abruptly from purple color of body.

Variety *bicolor*. Head whitish with tinge of brown, with broad, triangular dark brown dorsal marking which is widest behind, with its obtuse apex in the median line anteriorly. Color of body deep brown with a narrow median band of white. Brown color is darkest along the borders of the median white band, and is much paler laterally; toward the lateral margins of body it becomes pale brownish, and this color continues to the ventral surface, becoming gradually paler toward the median line.

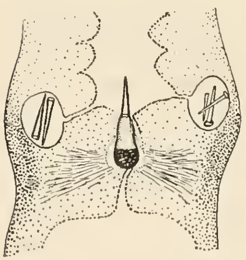

FIG. 57.— *Tetrastemma nigrifrons.* Stylet apparatus of proboscis

The third variety, *pallidum*, is much less deeply colored than those above described, and deep brown marking on the head is much narrower,

being often less than one third as wide as head. The marking is acutely triangular, with its pointed apex in the median line anteriorly. Body pale brownish, buff, deep flesh color, or occasionally whitish with a faint tinge of brown. A paler, or whitish, line often extends longitudinally on dorsal surface to posterior end of body; ventral surface pale buff or grayish throughout. The red blood vessels are naturally more conspicuous than in the darker varieties.

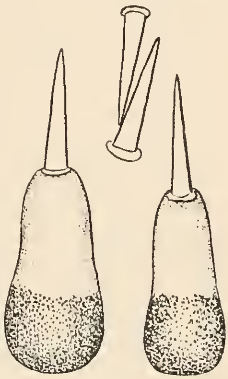

Fig. 58.— *Tetrastemma nigrifrons.* Central stylets and bases, showing more opaque posterior portions.

Other varieties are reddish brown, thickly sprinkled with minute dots of darker color on dorsal surface; ventral side of head white, with white median band extending posteriorly as far as intestinal region; rest of ventral surface reddish brown. Other specimens are brick red in esophageal region and chestnut brown posteriorly, with ventral surface grayish or pale reddish. In fact, there are all possible gradations between the most extreme color varieties, but all agree in having the cephalic marking dark brown in color.

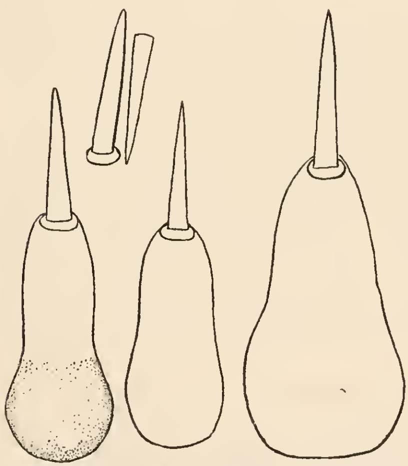

Fig. 59.— *Tetrastemma nigrifrons.* Outlines of accessory and central stylets and bases, showing variations in form and size. × 240.

Pigment to which color of body is due resides in integument, except that of the cephalic marking, which is placed deep among tissues of the head. Integument and pigment often sloughed off before death, leaving the body pinkish or flesh color, with the ocelli and red blood vessels showing very conspicuously.

General color of body is retained after preservation, and the cephalic marking is perfectly distinct even after imbedding in paraffin.

Ocelli of medium size; situated deep in tissues of head; their position varying greatly according to the state of contraction of anterior portion of body (Pl. **2**, fig. 26; Pl. **18**, fig. 113).

Size. — Commonly about 20–30 mm. long and 1 mm. wide, occasionally up to 70 mm. in length and 2 mm. in diameter.

Proboscis — Proboscis sheath extends to posterior end of body. Proboscis pale, provided with ten conspicuous nerves. Basis of central stylet of the ordinary conical form, with swollen, rounded posterior end, exhibiting considerable variation in size and shape; central stylet of moderate proportions, not particularly sharp, usually a little more than half as long as basis. There are commonly three (occasionally two or four) stylets in each of the two lateral pouches (Pl. **18**, fig. 115). Length of basis varies from 0.11–0.17 mm., and that of stylet from 0.06–0.09 mm. Posterior portion of basis dark and granular, becoming translucent in anterior half (Pl. **18**, figs. 114, 115; Text-figs. 57–59).

Cephalic glands fairly well developed in head, but not extending back to brain. Submuscular glands wanting.

Alimentary canal. — Rhynchodaeum remarkably short; intestinal caeca extend forward to dorsal brain lobes, uniting posteriorly beneath the stomach to form a broad median caecum from which other pairs of slender diverticula are given off at intervals, and these pass forward above the lateral nerves and end blindly anteriorly.

Blood vessels conspicuous in life because of the deep red color of the oval discoid corpuscles.

Nephridia extend forward as far as brain region, the tubules being largest anteriorly, where they ramify in the body parenchyma both above and below the lateral nerves, as well as beside the brain. A single pair of large efferent ducts are situated about on a level with the posterior ends of the dorsal ganglia, and commonly a pair of smaller efferent ducts are found well back in the esophageal region.

Cerebral sense organs situated ventrally some little distance in front of brain.

Habitat. — Common among algae between tides, Pacific Grove, California; abundant on piles of wharf, Monterey; in similar situations, San Pedro, California. Collections of bryozoans and small algae from piles at Monterey always furnished many specimens of this conspicuous, but variously colored, species when left standing a short time in sea-water. Sexually mature in September. As noted

above, these worms are very hardy, moving about actively for several hours after the pigmented integument has been sloughed off. When placed in formalin they do not break up spontaneously, but usually die intact and well extended.

77. Tetrastemma bicolor Coe.

Proc. Wash. Acad. Sci., **3**, p. 57, Pl. 1, fig. 6, 1901; Harriman Alaska Expedition, **11**, p. 57, 1904.

This strikingly colored nemertean presents the following peculiarities of appearance and structure: —

Body moderately slender, somewhat rounded throughout; of larger size than many forms of the genus, attaining a length of 50–60 mm. when well extended. Ocelli rather large, arranged in the form of a square.

Color bright brownish red or orange on dorsal surface, with narrow, sharply marked, median white stripe extending whole length of body; ventral surface gray or whitish. Anterior and lateral margins of head and lateral margins of body for a short distance back of head of same color as ventral surface.

Blood vessels conspicuous because of deep red color of corpuscles.

Proboscis rather large; basis of central stylet somewhat conical, swollen posteriorly, about .075 mm. in length, and about one and one half times as long as stylet itself. The two pouches of accessory stylets commonly contain three or four stylets each.

Habitat. — Known only from Kadiak, Alaska, occurring in about 3 fms. (Coe, :**01**). The species resembles some varieties of *T. vermiculus* Quatr., but lacks the dark pigment between the two ocelli of the same side which is found in the latter species, and has the median white stripe very sharp and conspicuous.

78. Tetrastemma aberrans Coe.

Proc. Wash. Acad. Sci., **3**, p. 58, 1901; Harriman Alaska Expedition, **11**, p. 58, 1904.

Pl. **22**, fig. 150.

This is a very minute species, individuals seldom exceeding 12 mm. in length; body moderately slender.

Ocelli.— The four ocelli are remarkable in that each consists of an irregular group of three to five isolated pigment masses of variable size (Pl. **22**, fig. 150). These groups are arranged in the form of a square as are usually the four simple eyes in related species. This condition has evidently arisen from the fragmentation of originally simple ocelli. Such a fragmentation often occurs in the fresh-water STICHOSTEMMA, and to a certain extent in numerous other forms, *Tetrastemma cruciatum* for example, having four double ocelli. It is probable that individuals of the present species will later be found in which the fragmentation is not carried to such an extent as in the specimens here described.

Color pale yellow throughout.

Proboscis has twelve nerves, although but ten are found in nearly all other species of the genus. Basis of central stylet rather slender, as is also the stylet itself. Accessory pouches as in related species.

Nephridia extend forward to brain, and are limited to a short distance in anterior portion of esophageal region; with a single efferent duct near the posterior end of each of the pair of main canals.

Cephalic glands well developed.

Intestinal caecum extends into anterior fourth of esophageal region. Pylorus opens into intestine far behind the most anterior sexual glands.

Cerebral sense organs large, situated immediately in front of brain and projecting somewhat laterally thereto.

Habitat.— Glacier Bay and Prince William Sound, Alaska. Among hydroids in 4 fms. and between tides (Coe, :**01**).

79. Tetrastemma albidum, sp. nov.

Pl. **9**, fig. 62; Pl. **17**, figs. 104, 105; Pl. **22**, figs. 145–149.

Body very slender, widest and somewhat flattened in intestinal region; head narrow, but not pointed anteriorly. Lateral, oblique grooves on head as usual.

Size.— Usually 10 to 15 mm. long and 0.5 to 1 mm. in width, although some individuals were at least 25 mm. in length.

Color.— Milk white, creamy, or flesh colored, somewhat influenced by color of intestinal canal and of sexual products when mature.

Some are very pale yellow anteriorly with gray intestinal tract and pale yellow brain ; others are pure white anteriorly with flesh colored or pale orange intestinal canal; in others intestinal canal is pale brownish. Mature ova are pale rose, and their presence gives a corresponding tone to intestinal region of ripe females. Males are whitish in a corresponding region. Intestinal caeca reach anteriorly as far as brain. A fine line of dark pigment sometimes occurs between the ocelli of the same side.

Ocelli.— In life anterior pair of ocelli are rather more widely separated from posterior pair than are the two ocelli of the same side; of medium size; sometimes anterior pair is slightly the larger, sometimes the posterior. They are often irregular in shape with root-like processes of pigment extending on all sides, but this is especially marked between the ocelli of the posterior pair (Pl. **17**, fig. 104; Pl. **22**, fig. 145). After preservation the four ocelli all lie anterior to the lateral grooves (Pl. **22**, fig. 146), but in life their relative position as regards the grooves depends upon the state of contraction of the parts.

Proboscis.— Proboscis sheath does not reach posterior end of body, but terminates in its posterior third. In this respect the species differs from nearly all other described forms of the genus. In one of several specimens sectioned, the proboscis sheath was bent sharply on itself and terminated some distance anterior to its most posterior portion. A section through this region in this particular individual consequently shows two sections of the proboscis sheath (Pl. **9**, fig. 62).

Proboscis sheath corpuscles pale yellow. Proboscis of comparatively large size, with slender central stylet, and slender basis, usually 3 to 4 times as long as thick, and usually somewhat longer than stylet itself (Pl. **17**, fig. 105). Basis is sometimes symmetrical and largest posteriorly, but more often somewhat irregular and larger a short distance behind insertion of stylet (Pl. **22**, figs. 147–149) than near the posterior end. Two lateral pouches each contain 2 to 4 (usually 3) slender accessory stylets. Basis of small size, as shown by the following measurements: Length .04 to .055 mm.; width .012 to .02 mm.; stylet .035 to .05 mm. long. Proboscis nerves are ten in number as usual.

Alimentary canal.— Intestinal caeca extend forward to posterior side of dorsal brain lobes. The slender posterior portion of the

pylorus extends about as far posteriorly beyond the most anterior sexual glands as the distance between these and the brain. In other words, the sexual glands extend forward through half the distance between the brain and the opening of pylorus into intestine.

Nephridia.— Nephridial canals are of large size and are situated both above and below the lateral nerves immediately posterior to the brain region. A single pair of large efferent ducts opens to the ventro-lateral surfaces of body a little posterior to the middle of the very short nephridial region.

Cerebral sense organs remarkably voluminous, extending from in front of brain back beneath the ventral ganglia nearly to the posterior border of latter.

Habitat.— Monterey, Pacific Grove, San Pedro, and San Diego, California, on piles and among algae. Very common in all localities.

Sexually mature in August and September. As in related species sexual glands reach well forward toward the head, and are densely packed throughout remainder of body. Mature ova are large; pale rose in color.

80. Tetrastemma bilineatum Coe.

Harriman Alaska Expedition, **11**, p. 164, Pl. 14, fig. 6; Pl. 21, figs. 13, 14; Pl. 22, fig. 4, 1904.

Pl. **1**, fig. 10; Pl. **2**, fig. 25.

This species, which is abundant on piles of wharves in San Diego Harbor, California, may be recognized by the following characters:

Body rounded throughout, moderately slender, of minute size, measuring only 5–10 mm. in length and less than 1 mm. in diameter; head provided with two pairs of faintly marked oblique grooves.

Color.— General color of body flesh color, creamy, or grayish, with two very conspicuous sharply marked brown, reddish brown or chocolate brown stripes extending nearly the whole length of dorsal surface (Pl. **1**, fig. 10; Pl. **2**, fig. 25); ventral surface grayish. Stripes terminate anteriorly between or somewhat in front of anterior ocelli, or sometimes reach to tip of snout. Diameter of each stripe perhaps one sixth the diameter of body, the two stripes being separated by about twice the diameter of each. Stripes retain deep brown color even after imbedding in paraffin.

Ocelli situated deep in tissues of head, of moderate size, usually occupying the corners of a square (Pl. **2**, fig. 25). There is no trace of pigment between the two ocelli of same side.

Proboscis provided with ten nerves. Central stylet rather slender; basis rather slender, slightly enlarged posteriorly, of very small size, being only about .05–.07 mm. in length, and .02–.025 mm. in width; each of the two lateral pouches contains two or three accessory stylets.

Pigment of longitudinal dorsal bands very conspicuous in every transverse section of body; it is situated in the inner portion of the ongitudinal muscular layer, appearing as an elongated dark mass on each side of proboscis sheath. Pigment masses often occupy whole thickness of this muscular layer.

Submuscular glands but little developed.

Intestinal caecum extends forward through about half the length of esophageal region.

Nephridia situated in the middle portion of the esophageal region. A single pair of efferent ducts, situated near anterior end of intestinal caecum, passes immediately above lateral nerves to open just ventral to lateral margins of body.

Cerebral sense organs remarkably voluminous; situated immediately in front of brain and extending somewhat beside and beneath ventral ganglia. Canal to exterior of large size, extending well forward to open below lateral margin in a shallow oblique furrow near tip of head.

Habitat. — Common among bryozoans, tunicates, and other growths on piles of wharves in the harbor of San Diego, California. Sexual products mature in August. Reproductive pouches of both sexes very voluminous, extending forward well anterior to opening of esophagus into intestine. Ova very large.

81. Tetrastemma quadrilineatum Coe.

Harriman Alaska Expedition, **11**, p. 166, Pl. 14, fig 5; Pl. 20, figs. 12, 13, 1904.

Pl. **2**, fig. 18; Text-fig. 60.

This species resembles both *T. vittatum* (Hubrecht[1]) Bürger

[1] Notes from Leyden Museum, p. 229, 1870.

(not *T. vittatum* Verrill[1]), and *T. quadristriatum* Langerhans[2] in general appearance, and in having four longitudinal brown lines on dorsal surface. In the former species, however, the four lines usually become confluent behind the head in two quadrangular patches which send two fine lines between the posterior pair of ocelli; in the latter species the two median lines extend to the tip of the head before uniting, while the lateral are interrupted between the ocelli and do not unite on tip of head. In *T. quadrilineatum*, as described below, the median lines reach nearly to tip of snout, but do not join each other, while the lateral lines usually end behind the ocelli.

Body short, broad and stout; somewhat flattened but with rounded margins; head usually narrower than body; provided with the usual pair of lateral oblique grooves which appear as slight constrictions opposite the posterior pair of ocelli. Intestinal caeca not much branched; reaching to brain region.

Size. — Length when sexually mature 8–12 mm.; width less than 1 mm.

Color. — General color of body whitish, with four longitudinal. deep brown stripes, two of which lie near lateral margins of body, the other two being placed symmetrically on the dorsal surface (Pl. **2**, fig. 18). Dorsal stripes about equal in width to the white median stripe which lies between them. They are narrower on head, and terminate anteriorly a little in front of the anterior pair of ocelli, Lateral stripes strictly marginal, much narrower than dorsal, and usually present a ragged appearance. They each terminate anteriorly in the vicinity of the lateral grooves on the head or a little behind them.

Head and esophageal region usually pure white except for the brown stripes; occasionally pale yellowish or flesh color. Intestinal region with tinge of yellow or salmon, due to color of intestinal lobes which show through other tissues. Ventral surface of same color as dorsal, but often with a tinge of salmon, flesh color, or greenish yellow in intestinal region. Proboscis whitish; brain pale yellow. Brown stripes of body remain conspicuous after preservation.

Ocelli of medium size, arranged nearly in the form of a square

[1] Amer. Journ. Sci., **7**, p. 45, 1874.

[2] Zeits. f. wiss. Zool., **34**, p. 136, 1880.

(Pl. 2, fig. 18); situated deep in the tissues of the head, and commonly lateral to the brown stripes.

Proboscis provided with ten large nerves. Basis of central stylet bell-shaped, short, much enlarged and rather abruptly truncated posteriorly (Text-fig. 60); commonly about .065 mm. in length, and .045 mm. in diameter near base. Central stylet rather small, about three fourths as long as basis. Each of the two lateral pouches usually contains two accessory stylets

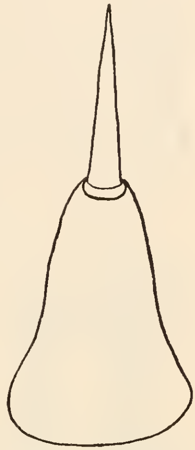

Fig. 60.— *Tetrastemma quadrilineatum.* Outline of central stylet and basis. × 410.

Cephalic glands well developed, filling up a considerable portion of the tissues of head in front of brain. A pair of broad diverticula of the intestinal caecum extend forward above and a little in front of dorsal brain lobes.

Nephridial system remarkable for its short extent, and because the large efferent ducts open on the head immediately beside the dorsal ganglia. Nephridial tubules lie above anterior portions of the lateral nerves and about the brain, but do not extend more than a very short distance behind the ganglia.

Central sense organs of moderately large proportions, situated a short distance in front of the brain.

Habitat.— Fairly common among ascidians and other growths on piles of wharf in San Pedro Harbor, California. Sexually mature in August. Ova large, opaque; pale greenish in color. In tide pools, among Cladophora, Pacific Grove, California (H. Heath).

82. **Tetrastemma (Oerstedia) dorsale** (Abildgaard) McIntosh.

Planaria dorsalis Abildgaard, Zoöl. Danic., **4**, p. 25, 1806.

Tetrastemma dorsalis McIntosh, British Annelids, Pt. I, Nemerteans, Ray Soc., p. 172, 1873.

Oerstedia dorsalis Bürger, Fauna und Flora des Golfes von Neapel, Monogr. 22, p. 592, 1895.

Tetrastemma (Oerstedia) dorsale Coe, Harriman Alaska Expedition, **11**, p. 169, 1904.

Pl. 2, fig. 19.

This small, widely distributed species may be recognized by its firm, slender, cylindrical body, usually only 8–15 mm. in length, somewhat narrower towards both extremities; flesh color or pale yellowish, mottled on dorsal surface with brownish blotches and dots of various shades and with considerable variation in distribution, often being mainly collected into a series of transverse bands with a few scattered blotches between (Pl. 2, fig. 19).

The head is continuous with body and provided with 4 ocelli. Proboscis armature as in other species of Tetrastemma.

Habitat.— On piles of wharves, and on rocks, among algae, bryozoans, ascidians and other growths. Widely distributed in Northern Hemisphere, occurring on the northern coasts of Europe, in the Mediterranean, and on both the east and west coasts of North America. Monterey Bay, California, in 20 fms. (J. F. Abbott).

83. **Tetrastemma (Oerstedia) reticulatum** Coe.

Harriman Alaska Expedition, **11**, p. 170, Pl. 14, figs. 7, 8; Pl. 20, figs. 7–9, 1904.

Pl. 2, figs. 16, 17; Text-figs. 61, 62.

This is a minute species, measuring but 8–15 mm. in length when sexually mature, and less than 0.5 mm. in diameter, much resembling typical species of Oerstedia in form and movement, as well as in firmness of body and in general appearance. The peculiarities of the species of this genus do not seem to be sufficiently pronounced, however, to warrant their separation from the genus Tetrastemma.

Body short, thick, rounded; head usually somewhat narrower than body, with a pair of oblique lateral grooves situated opposite posterior pair of ocelli.

Color.— Ground color of body white, with rectangular and longitudinal brown markings which obscure most of the white color of dorsal surface (Pl. 2, figs. 16, 17). Two varieties, presenting widely different arrangement of markings, were met with, and these in extreme cases would suggest two different species. Color of markings varies from light brown to chocolate or reddish brown. Head

white or colorless, provided with a similar transverse, deep brown marking in both varieties. This cephalic marking (Pl. 2, figs. 16, 17) consists of a broad transverse band of color extending laterally somewhat beyond the ocelli, and having a rounded and deeply bilobed anterior margin. Sixteen pairs of rectangular brown markings cover most of the dorsal surface in the most common variety. Markings usually very irregular in shape, in ordinary states of contraction about one and a half times as long as broad, and separated medially by a space about half as great as their own width. A pair of slender, irregular, brown lines are situated on lateral margins of body behind the head. Anteriorly these slender brown lines join the more anterior rectangular markings, but at about the third pair of rectangular markings become separated, to join again at the fourteenth to sixteenth pairs. Lateral lines often more or less closely connected by bridges or completely fused with the brown markings especially in the three most anterior and three most posterior pairs of markings (Text-fig. 61). When carried to the extreme condition all the markings on body back of head are fused with the lateral lines giving rise to a second distinct variety, having the whole dorsal surface back of head of a deep brown color interrupted by about fifteen irregular transverse whitish bands extending toward lateral margins (Pl. 2, fig. 17) and indicating the spaces between the sixteen pairs of rectangular markings described for the first variety. Lateral lines often completely lost in the rectangular markings, and both markings of the same pair completely lose their individuality, sometimes leaving a paler median line. Sometimes, moreover, the fusion is so complete that only a portion of the full number of transverse whitish bands can be found.

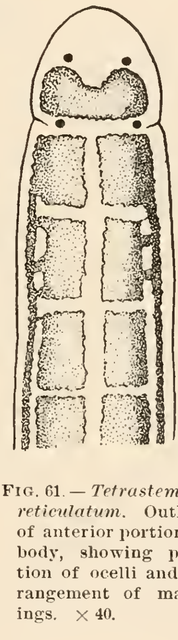

Fig. 61.— *Tetrastemma reticulatum.* Outline of anterior portion of body, showing position of ocelli and arrangement of markings. × 40.

Ventral surface commonly dull grayish with a tinge of yellowish in median line; often with numerous fine granules of brownish pigment and with a greenish tint in intestinal region when filled with ripe ova.

Ocelli of medium size and, as usual, arranged nearly in the form of a square (Pl. 2, fig. 17; Text-fig. 61).

Proboscis pale flesh color, of large size as compared with body of worm, provided with nine, or occasionally ten nerves. Basis of central stylet somewhat elliptical and only a little wider posteriorly than near attachment of stylet. Basis measures about .07 mm. in length and is about two and one half times as long as broad (Text-fig. 62). Posterior half of basis granular and dark, becoming more translucent anteriorly. Central stylet slender, about two thirds as long as basis; usually with two accessory stylets in each of the two lateral pouches.

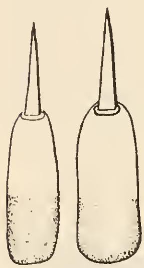

Fig. 62. — *Tetrastemma reticulatum.* Outlines of central stylets and bases in two individuals.

Cephalic glands voluminous, situated both above and beneath rhynchodaeum, and reaching back nearly to the brain.

Pigment of dorsal markings situated in integument.

Alimentary canal. — A pair of rather large diverticula of the intestinal caecum extend forward to dorsal side of brain, uniting shortly behind the mouth to form a broad, unpaired caecum with lateral diverticula beneath the stomach.

Nephridia limited to brain region, the tubules extending beside, as well as a very short distance behind, the ganglia; with a single pair of efferent ducts opening laterally just opposite posterior ends of dorsal ganglia.

Cerebral sense organs remarkably large; situated beside and beneath the ventral ganglia, and projecting somewhat in front of them.

Habitat.— Common on piles of wharf at San Pedro, California. Sexually mature in August or September. Sexual glands voluminous, extending anteriorly well toward brain region. Ova of large size (about .18 mm. in diameter), pale olive green in color, arranged in a single row along each side of intestinal region.

84. Tetrastemma caecum Coe.

Proc. Wash. Acad. Sci., **3**, p. 59, 1901; Harriman Alaska Expedition, **11**, p. 59, 1904.

Pl. **22**, fig. 151.

This minute species is especially remarkable, and quite aberrant

from most other forms of the genus, both in lacking ocelli and in being hermaphroditic.

Body rounded, of about the same diameter throughout; of minute size, being but 5 to 10 mm. in length and 0.5 to 1.0 mm. in diameter when sexually mature.

Ocelli completely wanting.

Color whitish or very pale yellowish with darker intestinal lobes.

Proboscis of enormous size when compared with that of body, when everted being practically equal to the diameter of the body itself (Pl. 22, fig. 151). Central stylet and basis very slender and delicate. Two accessory pouches each contain two or three slender stylets. Nerves more or less confluent.

Intestinal caecum extends forward well toward brain.

Cerebral sense organs remarkably voluminous as compared with other organs of head; situated immediately in front of brain and extending posteriorly on ventral side of brain lobes as far as ventral commissure.

Reproductive organs.— This species resembles *T. kefersteini* Marion in being hermaphroditic. The latter species is commonly parasitic in the mantle cavity of the tunicate Phallusia (Marion, '74), and it is possible that the present species commonly lives in a similar position in some Alaska tunicate.

Sexual products are mature in July. Ova are very large, fully two thirds the diameter of the body, and hence are arranged at irregular intervals in a single row (Pl. 22, fig. 151). Spermaries often alternate very irregularly with the ova, or may be grouped irregularly. Ova and spermatozoa are not usually mature at the same time in the same individual. When ova are mature spermaries are small, and when spermaries are mature and their ducts fully formed the ova are but half grown.

Spermaries usually open dorsally, but the exit of an ovum must cause a large break in the body walls. Marion ('74) considered it probable that in *T. kefersteini* deposition of the ova resulted in the death of the worm, and I have little doubt that this is often the case. The presence of immature spermaries in the worms with mature ova, however, makes it probable that some of the worms can survive the process of egg laying. It is possible that internal fertilization may take place in at least a portion of the individuals, as in the hermaphroditic Stichostemma.

Habitat. — Known only from Kadiak, Alaska, where a few specimens were dredged at a depth of about 3 fms. Possibly parasitic in tunicates or other invertebrates.

Planktonemertes Woodworth.

Bull. Mus. Comp. Zool., **35**, p. 2, 1899.

Woodworth's diagnosis of this genus of pelagic nemerteans is as follows: —

"A common external opening for the mouth and proboscis. Supraoesophageal ganglia smaller than suboesophageal. Median dorsal vessel present. Lateral diverticula of the intestine very numerous."

To this diagnosis the family characters of the Pelagonemertidae of Moseley to which the genus belongs may be added: "Pelagic nemerteans with broad, flattened, leaf-like, gelatinous, very hyaline body. Rhynchocoel extending nearly the entire length of the body. Proboscis unarmed. No cephalic grooves or organs of special sense. Intestinal tract dendrocoelous."

85. Planktonemertes agassizii Woodworth.

Bull. Mus. Comp. Zool., **35**, pp. 1–4, with 1 plate, 1899.

This very remarkable pelagic nemertean is represented in these collections by a single specimen taken by the Albatross at Sta. 2792 (Lat. 0° 37′ S., Long. 81° W.). This station is off the coast of Ecuador, and hardly comes within the limits covered by this report, but the species is mentioned here because other specimens have been collected off the coast of Panama. Five specimens have already been described in a preliminary paper by Woodworth ('**99**).

Body oval in shape, very much flattened, hyaline, with parallel undular sides, rounded at both ends.

Length of the six specimens known varies from 14 to 47 mm.; greatest width 16 mm.; thickness only 1 to 2.5 mm. Average length about two and one half to three and one half times as great as width.

Color orange, pink, or scarlet, the intestinal diverticula and proboscis being of deeper color.

Intestinal diverticula very numerous, commonly more than 50, with extremely numerous dendritic branches, of varying size and outline. These fill up the greater portion of the space within the body walls, so that but little body parenchyma is present.

Dorsal blood vessel extends backward in the ventral wall of rhynchocoel to unite with lateral vessels at posterior end of body.

Habitat. — Six specimens of this interesting form were taken by the Albatross in equatorial regions between 79° and 90° W. Long., where the water varied from 500 to 1800 fms. in depth. This area lies off the coasts of Ecuador and Panama, and near the Galapagos Islands.[1] The species is truly pelagic, however, so that the depth of the water probably has no influence in its distribution. A final paper dealing with the anatomical peculiarities of this remarkable form is promised by Dr. Woodworth.

Malacobdella Blainville.

Dict. Sci. Nat., 1827.

Parasitic nemerteans characterized by short, stout, much flattened bodies of leech-like appearance and movements, and provided with large rounded sucker at posterior end. Mouth and proboscis open close together or into a common atrium at the emarginate anterior end of body. Head not demarcated from body, without lateral grooves. Ocelli and cerebral sense organs wanting.

Proboscis sheath extends to posterior opening of intestine; proboscis slender, without stylets, but having a specialized bulb which apparently represents the degenerated stylet apparatus.

Intestine without diverticula, slender, convoluted, longer than body and opening posteriorly at base of sucker. Body parenchyma very voluminous.

Parasitic in branchial cavity of various species of marine lamelli-

[1] In a letter dated Nov. 28, 1904, Mr. Alexander Agassiz states (Amer. Journ. Sci., **19**, p. 145, Feb., 1905) that "two species of Pelagonemerteans" had just been taken by the surface nets of the Albatross between Peru and the Galapagos Islands, in water having a depth of less than 300 fms. It is not stated whether either species is identical with *P. agassizii*, previously taken in the vicinity, but the discovery of at least two species of these rare forms in the same locality is of great interest.

branchs (Venus, Mya, Pholas, Mactra, Cyprina, Cardium, and others).

86. Malacobdella sp.?

Mr. J. F. Abbott informs me that a representative of this genus occurs at Pacific Grove, California. It was found by him on one occasion only, and the specimens were lost before their specific characters were determined.

In addition to the species identified and described above, the collections from the U. S. National Museum contain a number of specimens which are insufficiently differentiated either in their external appearance or in their internal anatomical peculiarities to warrant any attempt at their classification or description. These unidentified specimens include principally species of Cerebratulus and Amphiporus.

Addendum.

Since the foregoing pages were put in type, I have been informed by Professor Harold Heath of Stanford University of the recent discovery of a species of Nectonemertes Verrill in Monterey Bay, California. This remarkable genus has previously been known only from a few individuals of a single species (*N. mirabilis* Verrill) collected in the North Atlantic Ocean.

Nectonemertes Verrill.

Trans. Conn. Acad. Sci., **8**, p. 447, Pl. 38, fig. 1, 1892.

Body broad and decidedly flattened, with thin lateral margins head broad; neck constricted, with pair of cirriform lateral appendages; posterior extremity produced into a broad, finlike appendage. Mouth and proboscis aperture separate; intestine straight, with lobed lateral diverticula; anus at end of caudal "fin." Musculature, blood vascular system, and position of lateral nerves much as in typical Hoplonemertea. Proboscis sheath extends nearly to posterior end of body; proboscis without stylets. Ocelli wanting. A cluster of peculiar organs, the nature of which is as yet undeter-

mined, end in small papillae on ventral surface of each side of head. The worms are more or less distinctly pelagic and probably swim actively.

Professor Heath has kindly sent me a brief account of the appearance and general anatomy of the species found in California. Some of the peculiarities of this form are as follows: —

Shape of body as in *N. mirabilis*, one individual having the following measurements: length 41 mm., greatest width 7.2 mm., width of head 5.3 mm., thickness of head 3.3 mm., greatest thickness of body region 2.5 mm., length of nuchal cirri 6 mm. Color in life bright scarlet; translucent. Mouth separate from proboscis pore; esophagus large, with glandular walls; intestinal caecum well developed, with lateral diverticula, the branches of which extend dorsally and inward nearly to median line; intestine with numerous branching diverticula, extending into caudal fin.

Three specimens were taken from the lines used by the Chinese in deep sea fishing near Monterey, California.

A detailed study of this most interesting form is being made by Professor Heath and Miss Mary Cravens, and is to be published in the Zoologische Jahrbücher. This study will doubtless determine more definitely the systematic position of this remarkable genus, which, as stated by Verrill ('92, p. 446), evidently belongs to the Hoplonemertea, although the proboscis is without armature; in this, as in many other peculiarities, the genus shows a rather close affinity with Pelagonemertes and Hyalonemertes, all the species of which are likewise pelagic.

It may later appear that one or both of the species referred to in the footnote on page 305 belong to this genus, and it is possible that one of them will prove to be identical with the species collected by Professor Heath.

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ERRATA.

Page 34, line 12: for "PELAGONEMERTES" read "Pelagonemerteans."

Page 34, line 14: after "CARCINONEMERTES" insert "and BAILCONEMERTES."

Page 57, line 29: for "*Cerebratulus nebulosus*" read "*Micrura nebulosa.*"

INDEX TO GENERA AND SPECIES.

Synonyms are in *italics*; species new to science, and pages on which generic or specific descriptions occur, are in **black face type**.

EXPLANATION OF PLATES.

ABBREVIATIONS.

a.	See explanation of figure.
ap.	Attachment of proboscis.
app.	Appendix of esophageal caecum.
bg.	Basal glands of integument.
bl.	Blood lacuna.
bm.	Basement membrane.
bm. ocm.	Basement membrane and outer circular muscles.
br.	Brain.
bv.	Blood vessel.
cac.	Cardiac caecum.
ci.	Cilia.
cm.	Circular muscles.
cso.	Cerebral sense organ.
ct.	Connective tissue.
dc.	Dorsal commissure.
dg.	Dorsal ganglion.
dm.	Diagonal muscles.
dn.	Dorso-median nerve.
dn'.	Internal dorso-median nerve.
dv.	Dorsal blood vessel.
e.	Esophagus.
ec.	Esophageal caecum.
eep.	Epithelium of esophagus.
emp.	Muscle for eversion of proboscis
en.	Esophageal nerve.
e. o.	Opening of esophagus into stomach.
fl.	Flagella.
fo.	Follicle; follicular epithelium.
gl.	Gland cell.
i.	Integument.
ic.	Intestinal caecum.
icm.	Inner circular muscles.
id.	Intestinal diverticulum.
iep.	Intestinal epithelium.
in.	Intestine.
inf.	Folds of intestinal wall.
lm.	Longitudinal muscles.
lmp.	Longitudinal muscle plate beneath proboscis sheath.

ln.	Lateral nerve.
lso.	Lateral sense organ.
lv.	Lateral blood vessel.
lv'.	Dorso-lateral blood vessel.
m.	Mouth.
n.	Nucleus.
nd.	Efferent nephridial duct.
nep.	Nephridia.
nv.	Nerve.
oc.	Ocellus.
ocm.	Outer circular muscles.
oep.	Outer epithelium of proboscis.
ov.	Ovum.
p.	Proboscis.
par.	Parenchyma.
pcm.	Circular muscles of proboscis.
pep.	Epithelium of proboscis.
plm.	Longitudinal muscles of proboscis.
pn.	Proboscidial nerve.
p. ps.	Proboscis and proboscis sheath.
ps.	Proboscis sheath.
pyl.	Pylorus.
r.	Rectum.
rc.	Rhynchocoel.
rcv.	Rhynchocoel vessel.
rh.	Rhynchodaeum.
ro.	Rhynchodaeal opening.
s.	Secretion.
sg.	Sexual gland.
smg.	Submuscular glands.
som.	Muscles of lateral sense organ.
st.	Stomach.
vc.	Ventral commissure.
vg.	Ventral ganglion.
vn.	Ventro-median nerve.
x.	See explanation of figure.
yn.	Yolk nucleus.

PLATE 1.

Fig. 1. *Carinella rubra* Griffin. Dorsal surface. × 2.

Fig. 2. *Carinella sexlineata* Griffin. Showing dorsal and lateral surfaces. × 3.

Fig. 3. *C. sexlineata.* Ventral surface. × 3.

Fig. 4. *Carinella albocincta* Coe. Dorsal surface. × 4. Off San Pedro, California; 50 fms.

Figs. 5, 6. *Amphiporus angulatus* (Fabr.). Dorsal and ventral surfaces respectively. × 3.

Fig. 7. *Paranemertes peregrina* Coe. Purple variety. Showing both dorsal and ventral surfaces. × 1½. Alaska.

Figs. 8, 9. *P. peregrina.* Brown variety. Dorsal and ventral surfaces respectively. × 2.

Fig. 10. *Tetrastemma bilineatum* Coe. Dorsal surface. × 4. San Diego, California.

Fig. 11. *Amphiporus rubellus* Coe. Dorsal surface, with extruded proboscis. × 2.

Fig. 12. *A. rubellus.* Anterior portion of body. × 2.

Fig. 13. *Amphiporus cruentatus* Verrill. Dorsal surface. Red lines represent blood vessels with red blood. × 10. San Pedro, California.

Fig. 14. *Emplectonema gracile* (Johnst.). Pale green variety. × 1½. 14a. Ventral side of head.

Fig. 15. *E. gracile.* Dark, bluish green variety. × 1½. 15a. Ventral side of head.

(Drawings by B. B. Griffin and W. R. Coe.)


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14a
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PLATE 2.

Fig. 16. *Tetrastemma reticulatum* Coe. Variety with rectangular markings. Dorsal surface. × 6. San Pedro, California.

Fig. 17. *T. reticulatum.* Variety with confluent markings. Dorsal surface. × 15. San Pedro, California.

Fig. 18. *Tetrastemma quadrilineatum* Coe. Dorsal surface. × 15. San Pedro, California.

Fig. 19. *Tetrastemma* (*Oerstedia*) *dorsale* (Abildgaard). Reddish variety. Dorsal surface. × 8. Monterey Bay, California.

Fig. 20. *Carcinonemertes epialti* Coe. Dorsal surface. × 10. Monterey Bay, California.

Fig. 21. *Amphiporus bimaculatus* Coe. Dorsal surface. × 3. Monterey Bay, California.

Fig. 22. *Amphiporus flavescens* Coe. Dorsal surface. × 3. San Pedro. California.

Fig. 23. *Amphiporus fulvus* Coe. Dorsal surface. × 3. San Pedro, California.

Fig. 24. *Tetrastemma signifer* Coe. Dorsal surface. × 5. San Pedro, California.

Fig. 25. *Tetrastemma bilineatum* Coe. Dorsal surface. × 14. San Pedro, California.

Fig. 26. *Tetrastemma nigrifrons* Coe. Proboscis extruded. Dorsal surface. × 6. Monterey Bay, California.

Fig. 27. *Lineus albolineatus* Coe. Showing both dorsal and ventral surfaces. × 5. Monterey Bay, California; 20 fms.

(Figs. 21, 26, 27 after drawings by J. F. Abbott; others by W. R. Coe.)


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PLATE 3.

Fig. 28. *Lineus torquatus* Coe. Head and anterior portion of body from lateral surface. Natural size. Prince William Sound, Alaska.

Fig. 29. *Micrura nigrirostris* Coe. Dorsal surface. × 6. San Pedro, California.

Fig. 30. *Lineus flavescens* Coe. Dorsal surface. × 6. San Pedro, California.

Fig. 31. *Micrura pardalis* Coe. Showing both dorsal and ventral surfaces. × 5. Monterey Bay, California.

Fig. 32. *Cerebratulus herculeus* Coe. Dorsal surface. Natural size. Sitka, Alaska.

Fig. 33. *Lineus rubescens* Coe. Dorsal surface. × 4. Monterey Bay, California.

Fig. 34. *Micrura verrilli* Coe. Body well extended, showing both dorsal and ventral surfaces; with regenerating posterior end. × $1\frac{1}{2}$. Monterey Bay, California.

Fig. 35. *M. verrilli.* Body contracted, showing dorsal and lateral surfaces; with caudal cirrus. × 2. Monterey, California.

Fig. 36. *Lineus pictifrons* Coe. Dorsal surface. Transverse yellow markings rather more prominent than in most individuals. × 2. San Pedro, California.

Fig. 37. *Lineus wilsoni* Coe. Showing both dorsal and ventral surfaces. × 2. Monterey Bay, California.

Figs. 38,39. *Cerebratulus montgomeryi* Coe. Ventral and dorsal surface of head and anterior portion of body. Natural size. Unalaska Island, Alaska.

(Fig. 35 after drawing by J. F. Abbott, others by W. R. Coe.)


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PLATE 4.

Fig. 40. *Euborlasia maxima* Coe. After preservation, and therefore strongly contracted. About natural size. Gulf of California.

Fig. 41. *Cerebratulus latus* Coe. Contracted, after preservation. Three fourths natural size. Bering Sea; 68 fms.

Fig. 42. *Cerebratulus signatus* Coe. Contracted, after preservation. × 3. Bering Sea; 61 fms.

Fig. 43. *C. signatus.* Lateral view of head and anterior portion of body. × 3.

Fig. 44. *Cerebratulus lineolatus* Coe. Lateral view of head and anterior portion of body. After preservation. × $1\frac{1}{2}$.

(Drawings by A. H. Verrill.)

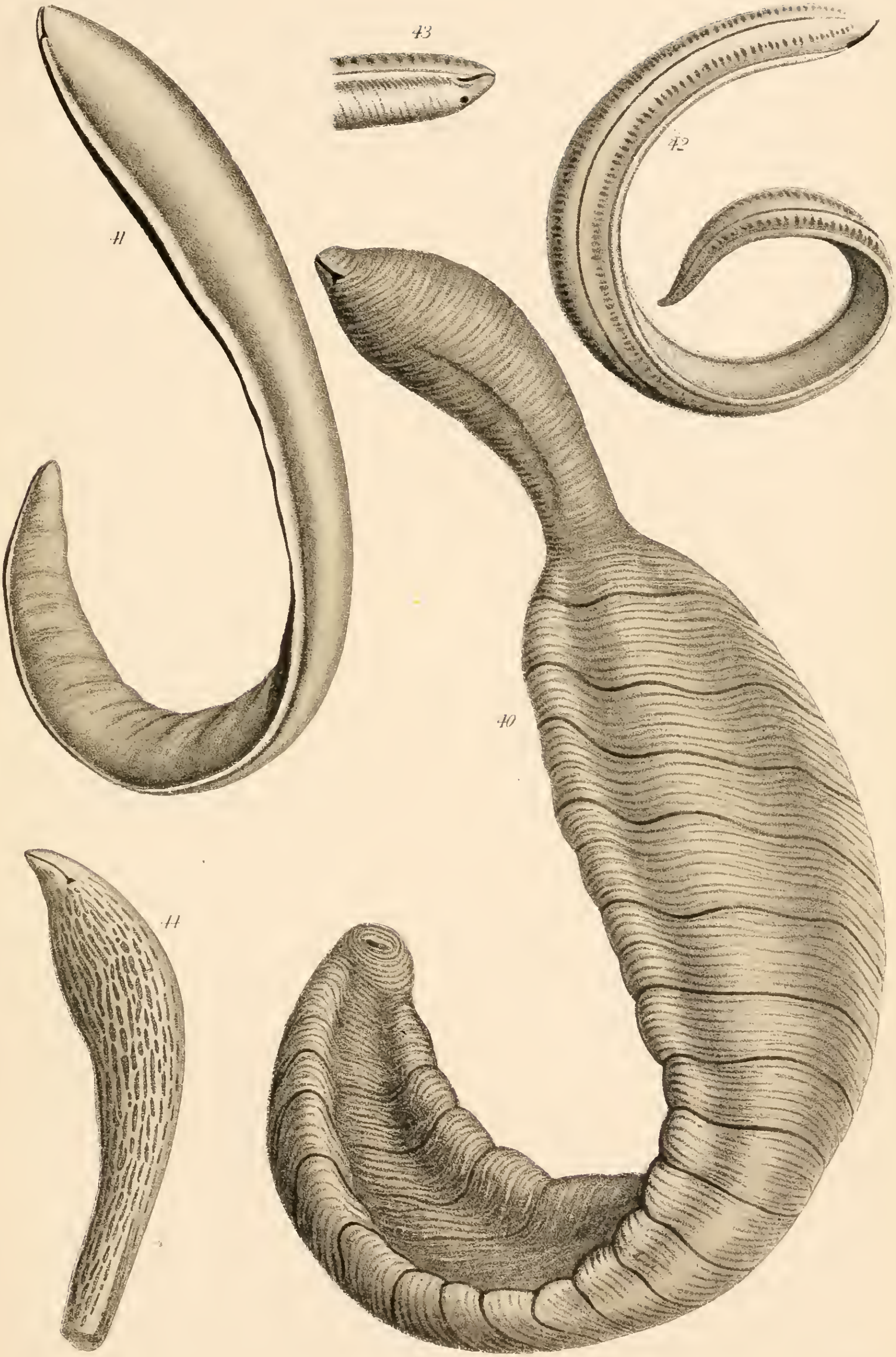
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PLATE 5.

Carinomella lactea Coe.

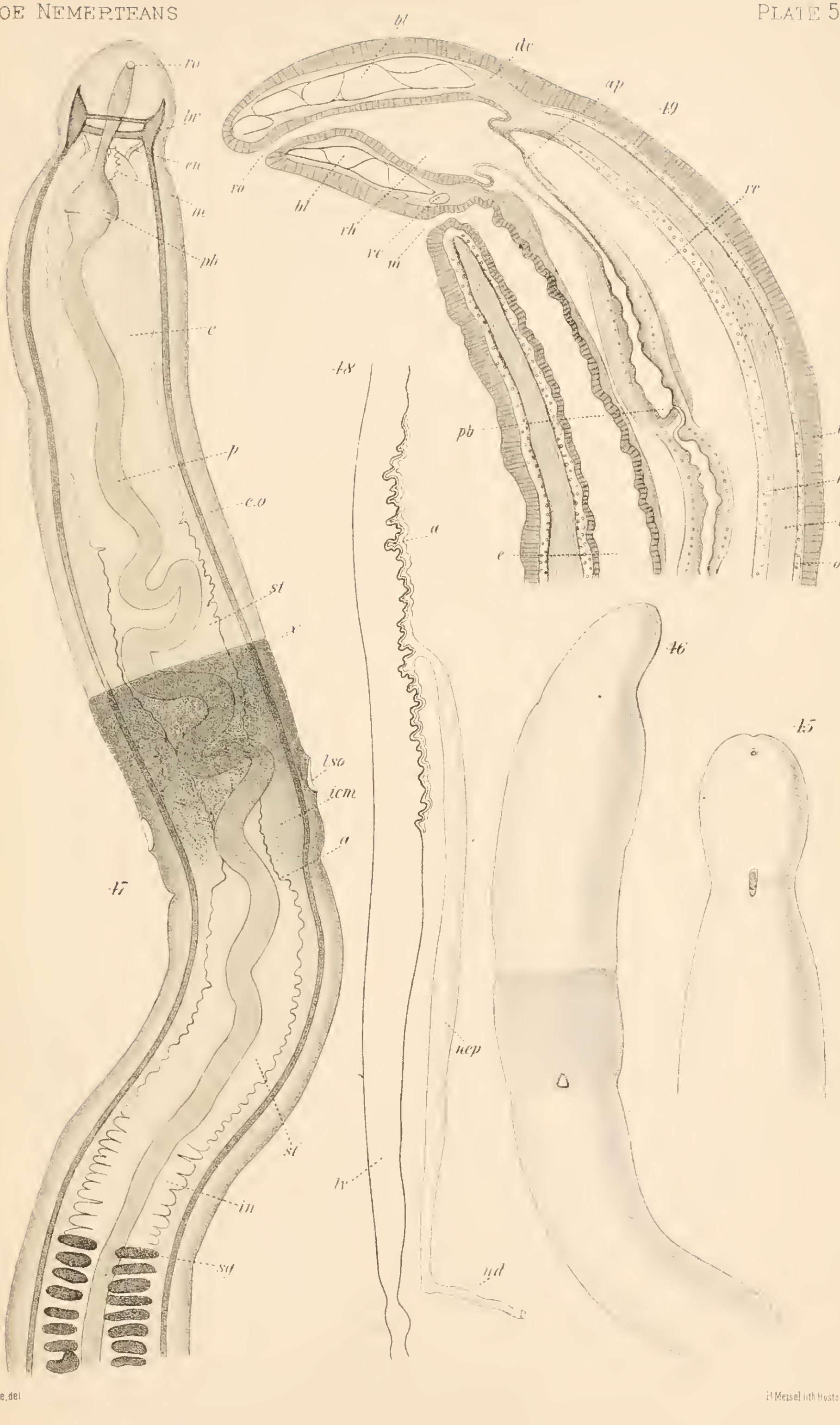
Fig. 45. Ventral side of anterior portion of body showing position of mouth and proboscis pore. × 16.

Fig. 46. Side view of anterior portion of body, showing dark band of differentiated epithelium, with the lateral sense organ indicated as a colorless spot near its posterior border. × 16.

Fig. 47. Somewhat diagrammatic dorsal view of specimen cleared in cedar oil after staining lightly. The contracted proboscis bulb (*pb*) appears just behind the mouth. Anterior limit of differentiated dark band shown at *x*. The position of the lateral sense organs (*lso*) and outline of the alimentary canal are shown. The thickening of the inner circular muscle ceases at *a*, and the narrow lumen of the stomach enlarges at the same region. The sexual glands (*sg*) are here more regularly placed than is the case more posteriorly. × 26.

Fig. 48. Diagrammatic reconstruction of nephridial system. The fine nephridial tubules which indent distal wall of lateral blood vessel (*lv*), constituting the so-called nephridial gland, extend both anterior (*a*) and posterior to the origin of the main nephridial duct (*nep*), which passes much farther posteriorly to open on dorso-lateral surface of body by a smaller efferent duct (*nd*).

Fig. 49. Median sagittal section through anterior portion of body, showing rhynchodaeum (*rh*), attachment of proboscis (*ap*), proboscis bulb (*pb*), mouth (*m*), esophagus (*e*), cephalic blood lacunae (*bl*), and brain commissures. ×40.



Coe, del B Meisel lith Boston

PLATE 6.

Carinomella lactea Coe.

Fig. 50. General view of body in natural position. × 3.

Fig. 51. Sketch of anterior portion of body of living worm, showing position of rhynchodaeal opening (*ro*), mouth (*m*), brain (*br*), proboscis (*p*), and sexual glands (*sg*). × 12.

Fig. 52. Ideal sagittal section of head, showing, by comparison with Fig. 51, the much flattened head and the relation of mouth and rhynchodaeal openings. × 12.

Fig. 53. Transverse section through head in front of brain, showing the enormous blood lacunae (*bl*), with the rhynchodaeum (*rh*) suspended in their midst by thin shreds of tissue; *nv*, cephalic nerves. × 72.

Fig. 54. Transverse section of esophageal region shortly behind mouth. On each side of proboscis (*p*) is a thick band of muscle (*emp*) which enters proboscis a little more posteriorly and furnishes its muscular attachment. Both upper and lower dorso-median nerves are indicated. × 72.

Note.— Figs. 53, 54, 55, 56, 57, 58, 59, 63, Pls. **6** to **10** form a series of transverse sections through the principal anatomical regions of the body.

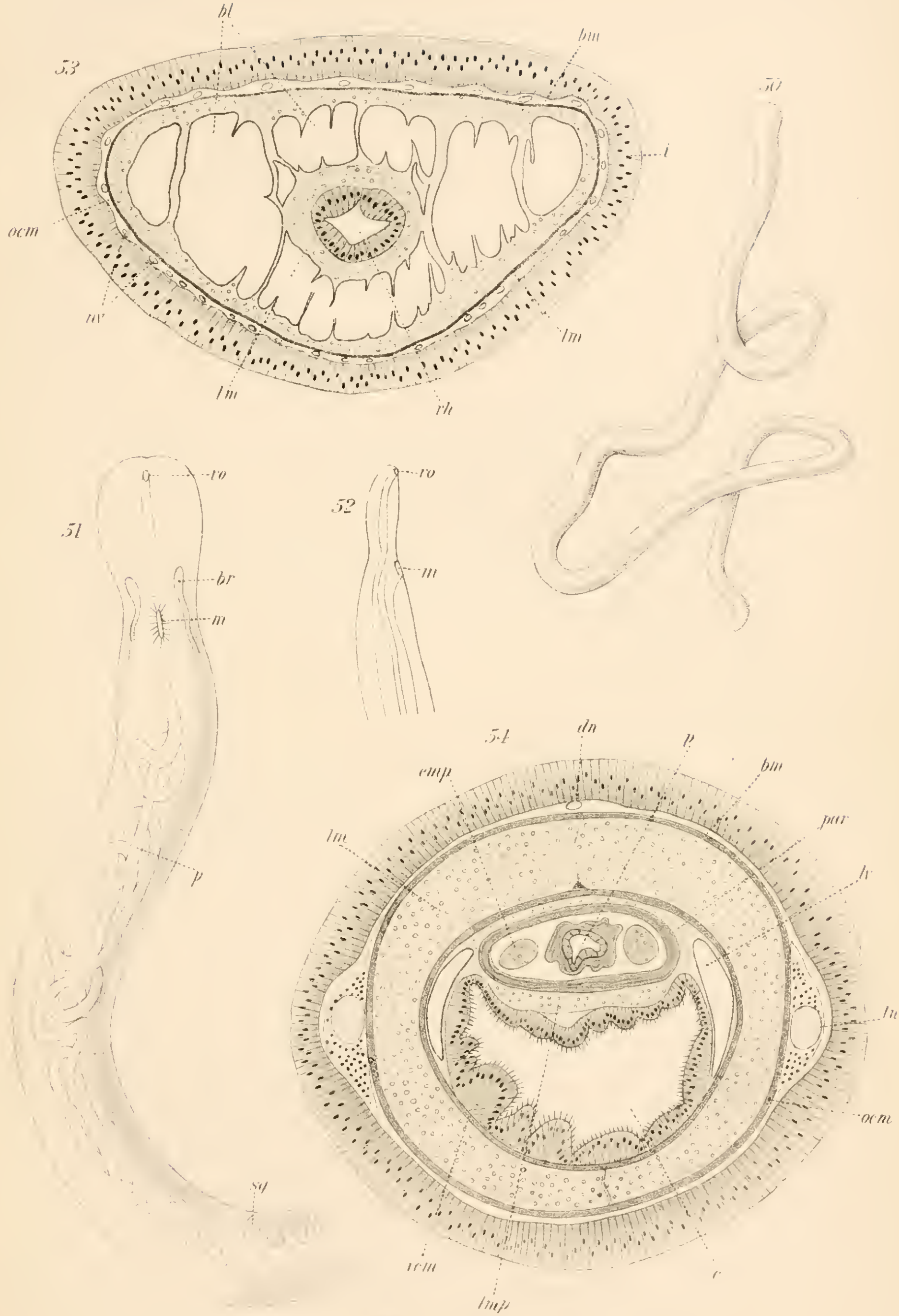


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PLATE 7.

Carinomella lactea Coe.

Fig. 55. Transverse section of body somewhat anterior to nephridial region. Longitudinal muscles are seen to completely surround the proboscis sheath. Sponge-like outgrowths from the lateral blood vessels pass into the proboscis sheath. Both dorsal and ventral fibrous crossings between outer and inner circular muscular layers are indicated, as are also the three median nerves. Lateral vessels have passed outside inner circular muscles. × 72.

Fig. 56. Transverse section of body through lateral sense organs. The muscles of the sense organs are indicated (*som*). The section is through the large nephridial ducts, which lie on the dorsal wall of the lateral blood vessels, and posterior to the smaller nephridial tubules. The integument shows the dorsal infolding and the differentiated glands of the dark band. The circular muscles are enormously developed, while the lumen of the stomach is narrow. × 72.

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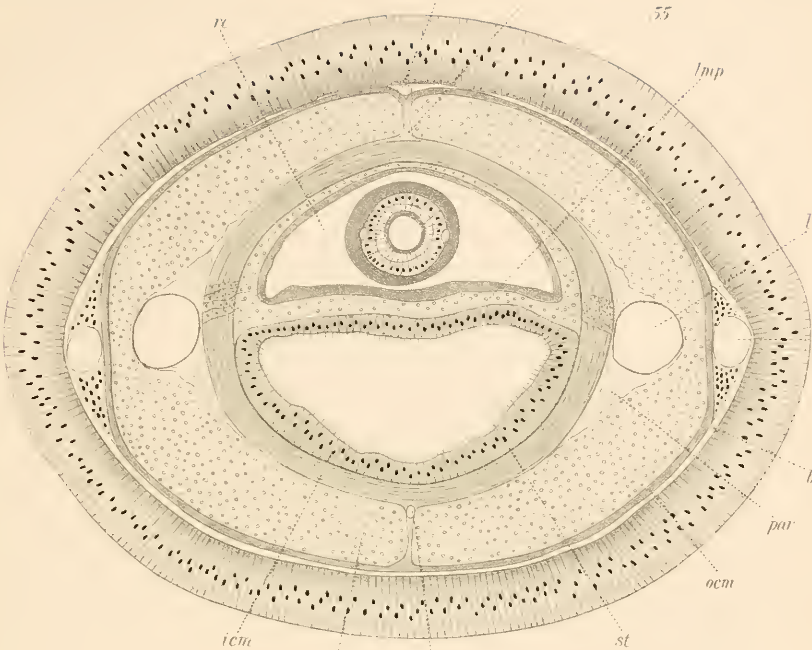
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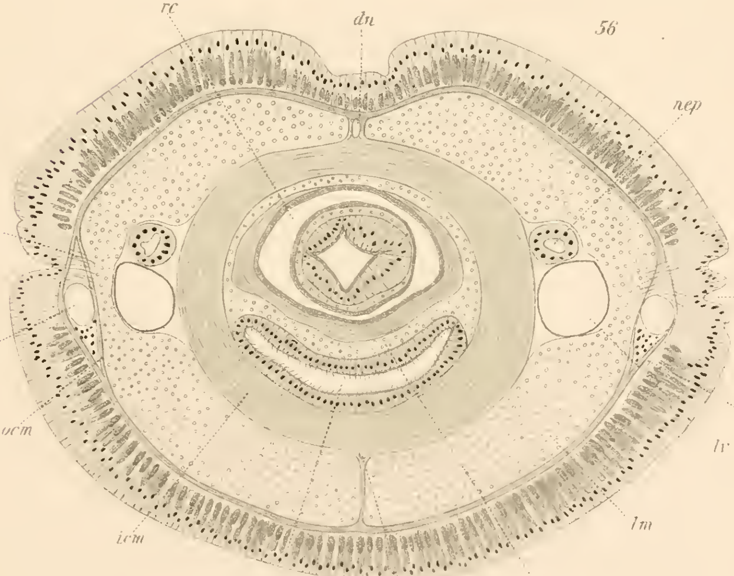
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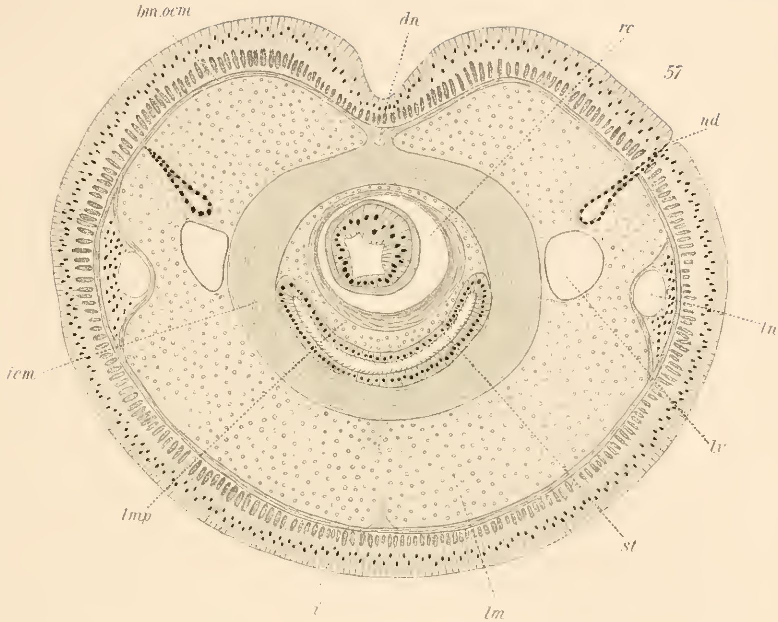
PLATE 8.

Carinomella lactea Coe.

Fig. 57. Transverse section of body through posterior end of nephridial region. The two efferent ducts (*nd*) are almost exactly paired. The dorsal infolding of integument is very marked, and all longitudinal muscles are wanting in the median line above the proboscis sheath. The greatly thickened inner circular muscles almost disappear a few sections farther posteriorly. The lateral nerve cords are pressed closely against the outer circular muscles. × 72.

Fig. 58. Transverse section of body posterior to the nephridial region and the thickening of inner circular muscles. These muscles are represented only by a few delicate fibers surrounding the proboscis sheath and stomach. The muscular walls of the proboscis sheath have almost disappeared, but the thick plate of longitudinal muscles (*lmp*) lying between the sheath and the stomach has become enormously developed. The lumen of the stomach has increased suddenly in size, and the lateral nerve cords have migrated to the midst of the longitudinal muscles, by which they are surrounded on three sides. × 72. Cf. Pl. **9**, figs. 60, 61.

Note.—Figs. 53, 54, 55, 56, 57, 58, 59, 63, Pls. **6** to **10** form a series of transverse sections through the principal anatomical regions of the body.



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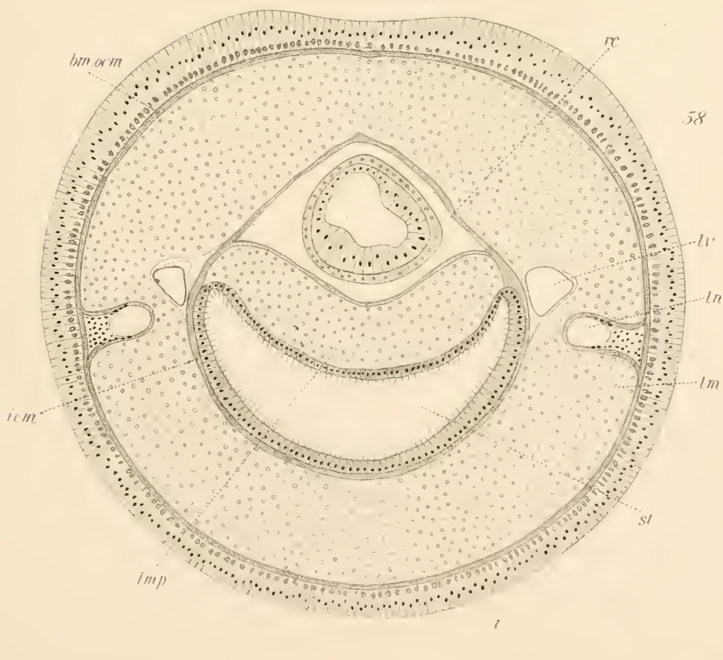

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PLATE 9.

Figs. 59 to 61, *Carinomella lactea* Coe.
Fig. 62, *Tetrastemma albidum* Coe.

Fig. 59. Transverse section of body through the anterior sexual glands, and near posterior end of proboscis sheath. The band of longitudinal muscles (*lmp*) is beginning to diminish in size, the inner circular muscles can hardly be demonstrated. and the proboscis sheath is almost without muscular walls. The lateral nerves have partially regained their original position between outer circular muscles and basement layer. The dorsal fibrous crossing is indicated, but the ventral has disappeared. The ova are well developed, but their ducts are not yet formed. × 72.

Fig. 60. A portion of a section from the same region as that shown in Fig. 58, Pl. **9**, more highly magnified. The relations of nerve core to its cellular sheath, situated between it and the basement layer, are shown. A very few delicate fibers of the outer circular muscle apparently pass internally to the nerve core. A few connective tissue fibers unite the sheath of the nerve core with the parenchyma about the lateral blood vessel. In this region all the nuclei of the stomach epithelium lie deep in the cells. × 170.

Fig. 61. Sagittal section in about the same region as in Fig. 58, showing the conspicuous transverse folds (*a*) of the epithelium of ventral side of stomach. These folds are largely due to the contracted condition of the specimen. The thick band of longitudinal muscles (*lmp*) is shown between rhynchocoel (*rc*) and stomach. × 72.

Fig. 62. *Tetrastemma albidum* Coe. Transverse section of body in intestinal region, showing a peculiar condition in which the proboscis sheath bends forward after reaching nearly to the posterior end of the body. × 125.

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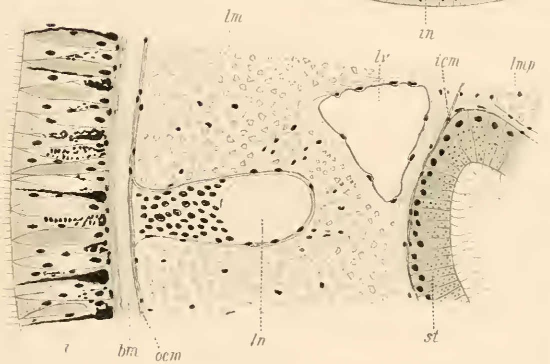
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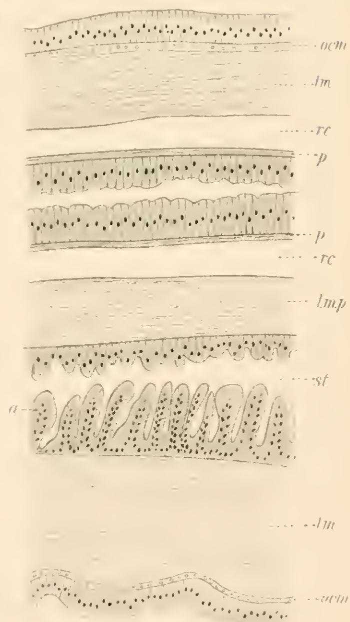
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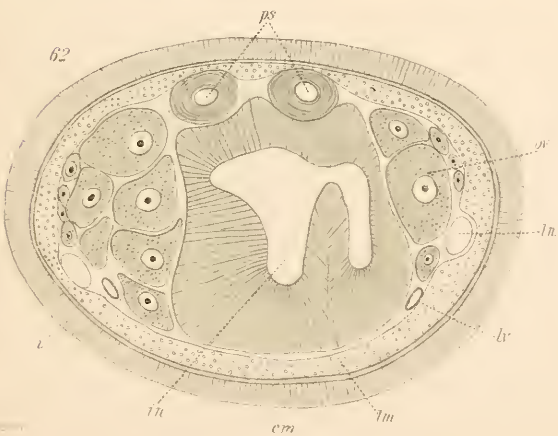
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PLATE 10.

Carinomella lactea Coe.

Fig. 63. Transverse section of body near middle of intestinal region. Proboscis sheath has disappeared. Intestinal walls are lined with highly columnar epithelium, which is thrown up into folds. Lateral blood vessels are distended more than in some of the neighboring sections. Ova are well developed, and oviducts are nearly ready for their discharge. Lateral nerves have regained a position outside circular muscles. × 72.

Fig. 64. Longitudinal section near middle of intestinal region in a position indicated by BB in Fig. 63, and in such a manner as to cut directly through the intestinal folds (*inf*) with the pouches between them. Smaller and incipient folds (*inf'*) appear between the larger folds. The section passes directly through the lateral blood vessel and the lateral nerve core. The integument is higher on the dorsal than on the ventral surface. × 72. Cf. Figs. 63 and 65.

Fig. 65. Longitudinal section near middle of intestinal region, in a position indicated by AA in Fig. 63. The intestinal epithelium is thrown up into high folds (*inf*) with alternating, slender pouches. These are especially conspicuous on the ventral side of the stomach, but probably represent little more than temporary folds. The sexual glands are closely packed together above the intestine. × 72. Cf. Figs. 63 and 64.

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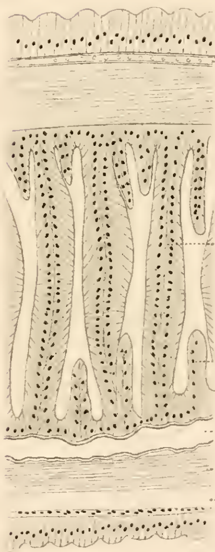

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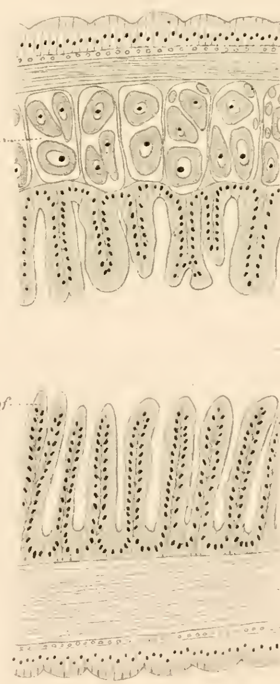

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PLATE 11.

Figs. 66 to 72, *Carinomella lactea* Coe.
Figs. 73 and 74, *Nemertopsis gracilis* Coe.
Fig. 75, *Paranemertes californica* Coe.

Fig. 66. Portion of transverse section of proboscis through middle chamber somewhat in front of nephridial region of body, as in Fig. 71. The peculiar columnar epithelium (*pep*), apparently provided with long flagella (*fl*) which end in a mass of deeply-stained secretion (*s*), is indicated, as are also the layer of connective tissue, basement layer and muscular layers. × 700.

Fig. 67. Portion of transverse section of anterior chamber of proboscis in same region as Fig. 68. The character of epithelial lining, the thick basement membrane, one of the two proboscidial nerves, and relations of other layers are shown. × 700.

Fig. 68. Transverse section of proboscis through anterior chamber near bulb-like enlargement. (Compare *pb*, Pl. **5**, figs. 47 and 49.) × 110.

Fig. 69. A similar section through canal leading from anterior to middle chamber. × 110.

Fig. 70. A similar section through anterior portion of middle chamber. × 110.

Fig. 71. A similar section through middle chamber somewhat in front of nephridial region of body. Compare Fig. 66. × 110.

Fig. 72. Two rhabdite cells from posterior chamber of proboscis, showing small, rod-like rhabdite bodies (*a*) imbedded side by side in outer portion of cell; *x*, cell nucleus. × 1000.

Fig. 73. *Nemertopsis gracilis.* Sketch of anterior portion of body after clearing in cedar oil, showing the two longitudinal markings (*a*), the brain (*br*), cerebral sense organs (*cso*), and the four large ocelli (*o*). × 25.

Fig. 74. *N. gracilis.* Basis and portion of central stylet. × 280.

Fig. 75. *Paranemertes californica.* Central stylet and basis. × 135.

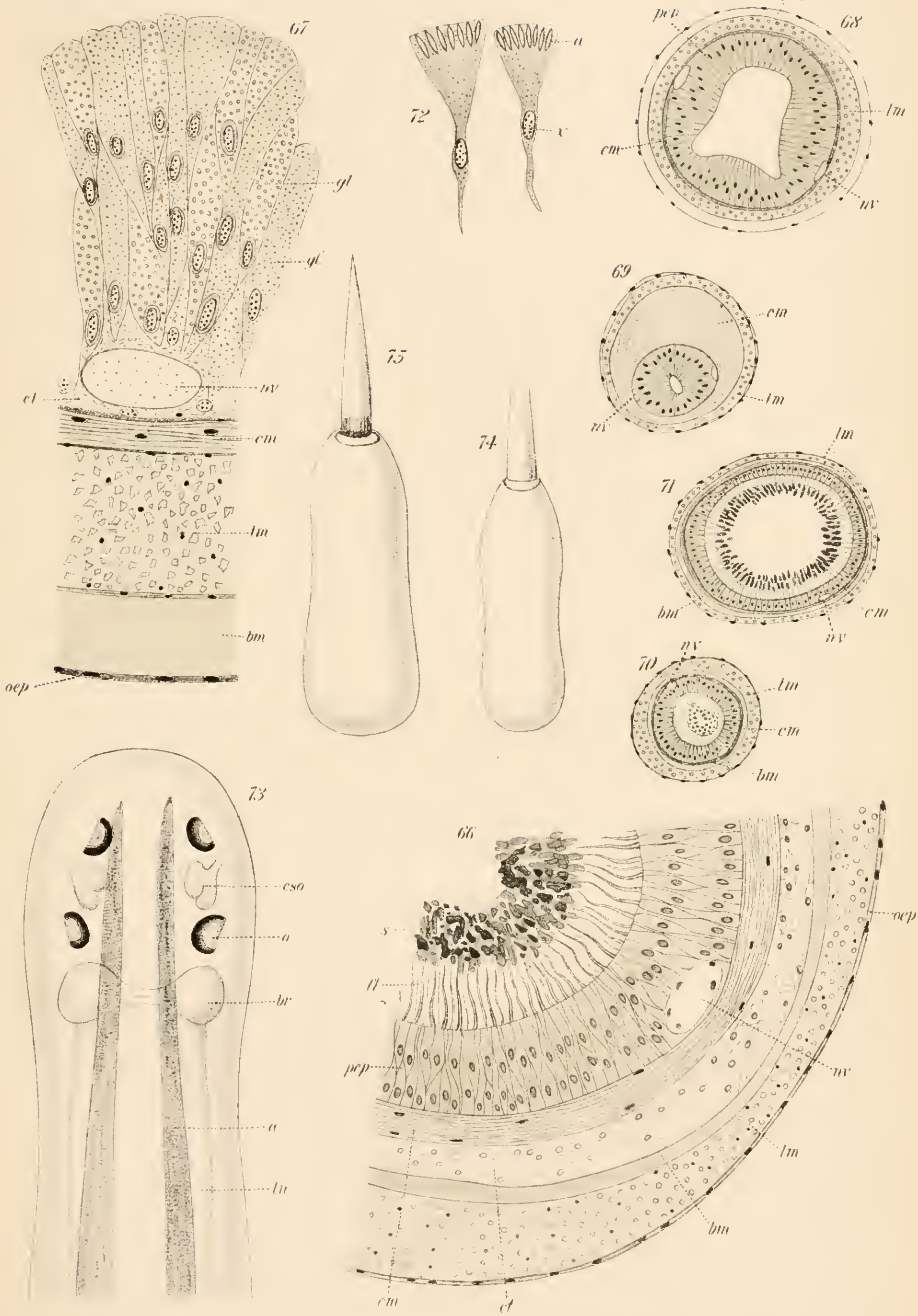
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PLATE 12.

Carinoma mutabilis Griffin.

Fig. 76. Ventral view of anterior portion of body of specimen cleared in cedar oil, showing relation of rhynchodaeal opening (*ro*), mouth (*m*), esophagus (*e*), stomach (*st*), intestine, intestinal diverticula (*id*), and sexual glands (*sg*). At *x* occurs the great thickening of the internal circular muscles, the stomach at the same point being reduced to a narrow canal. × 26.

Fig. 77. Posterior portion of body of specimen cleared in cedar oil, showing the gradual decrease in size of the intestinal diverticula (*id*) at the approach to the rectum (*r*), and a corresponding increase in the body parenchyma (*par*). × 26.

Fig. 78. Transverse section through head in front of brain, showing disposition of cephalic blood lacunae (*bl*) about the rhynchodaeum (*rh*), and the great development of glands (*gl*) beneath the integument (*i*). × 64.

Fig. 79. Portion of transverse section through anterior portion of esophageal region, showing disposition of outer circular (*ocm*), diagonal (dm), longitudinal (*lm*) and inner circular (*icm*) musculatures; *bm*, basement membrane; *gl*, glandular layer of integument; *a*, delicate integumental musculature. × 80.

Fig. 80. Transverse section of proboscis, showing the epithelial and muscular layers and the pair of large nerves. × 380.

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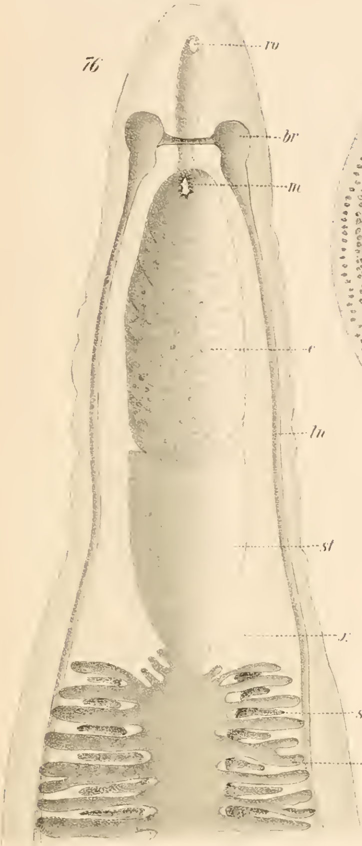

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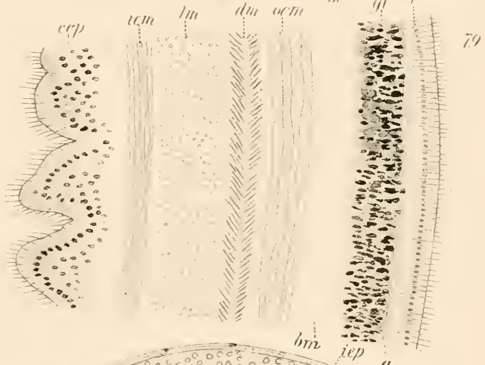

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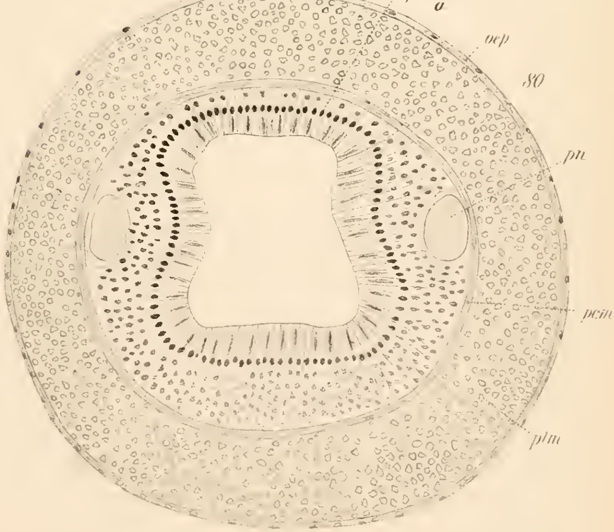

Coe del

B.Meisel lith Boston

PLATE 13.

Carinoma mutabilis Griffin.

Fig. 81. Transverse section of body in esophageal region, showing outer circular, diagonal, longitudinal and inner circular muscular layers, the ventral and dorsal pairs of lateral blood vessels (*lv*, *lv'*), the rhynchocoel vessels (*rcv*), the dorsal and ventral median nerves, etc. × 40.

Fig. 82. Transverse section of body in posterior portion of stomach region, showing the enormously developed inner circular musculature, and the narrow lumen of stomach and of proboscis sheath. On both sides of body two nephridial canals are cut (*nep*), those on the right side being cut a little more posteriorly than those on the left, where the section passes through the efferent nephridial duct (*nd*). Compare Pl. **14**, figs. 83, 84. On the right side the efferent duct is seen in section, in contact with the dorsal lateral vessel (*dv'*), and its course to the exterior indicated by dotted lines. The dorsal and ventral median nerves are conspicuous in this region of the body. × 40.

Note.— Figs. 78, 81, 82, 83, 87, 88, 89, Pls. **12** to **15** forms a series of transverse sections through the principal anatomical regions of the body.

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Coe del. B.Meisel lith. Boston.

PLATE **14**.

Carinoma mutabilis Griffin.

Fig. 83. Transverse section of body at anterior end of intestinal region and immediately behind posterior end of inner circular musculature, showing the two limbs of the nephridial canal (*nep*), of which the one nearer the lateral nerve is the limb which passes into the efferent nephridial duct (compare Fig. 84). The single pair of lateral vessels (*lv*) have contracted walls. × 40.

Fig. 84. Reconstruction of nephridial system, showing the complex system of minute tubules constituting the nephridial gland (*a*), encroaching on the walls of the lateral blood vessel (*lv*), and then uniting into a single large canal (*nep*) which passes into intestinal region and then bends forward (*nep'*) to the efferent duct (*nd*). The asterisk (*) marks boundary between stomach and intestine proper.

Fig. 85. Transverse section of lateral blood vessel and the nephridial gland (in position marked *a*, Fig. 84), showing the minute nephridial tubules projecting into the cavity of the blood vessel but without having direct communication therewith. Several blood corpuscles (*a*) are represented in lateral vessel. × 500.

Fig. 86. Three blood corpuscles, showing the small but conspicuous nucleus (*a*) and several rounded pigment bodies (*x*) in each. × 3500.

Fig. 87. Transverse section of body in intestinal region, showing the large intestinal diverticulum (*id*), ovary (*ov*), muscular layers, etc. From a small individual. × 70.

Note.—Figs. 78, 81, 82, 83, 87, 88, 89, Pls. **12** to **15** form a series of transverse sections through the principal anatomical regions of the body.

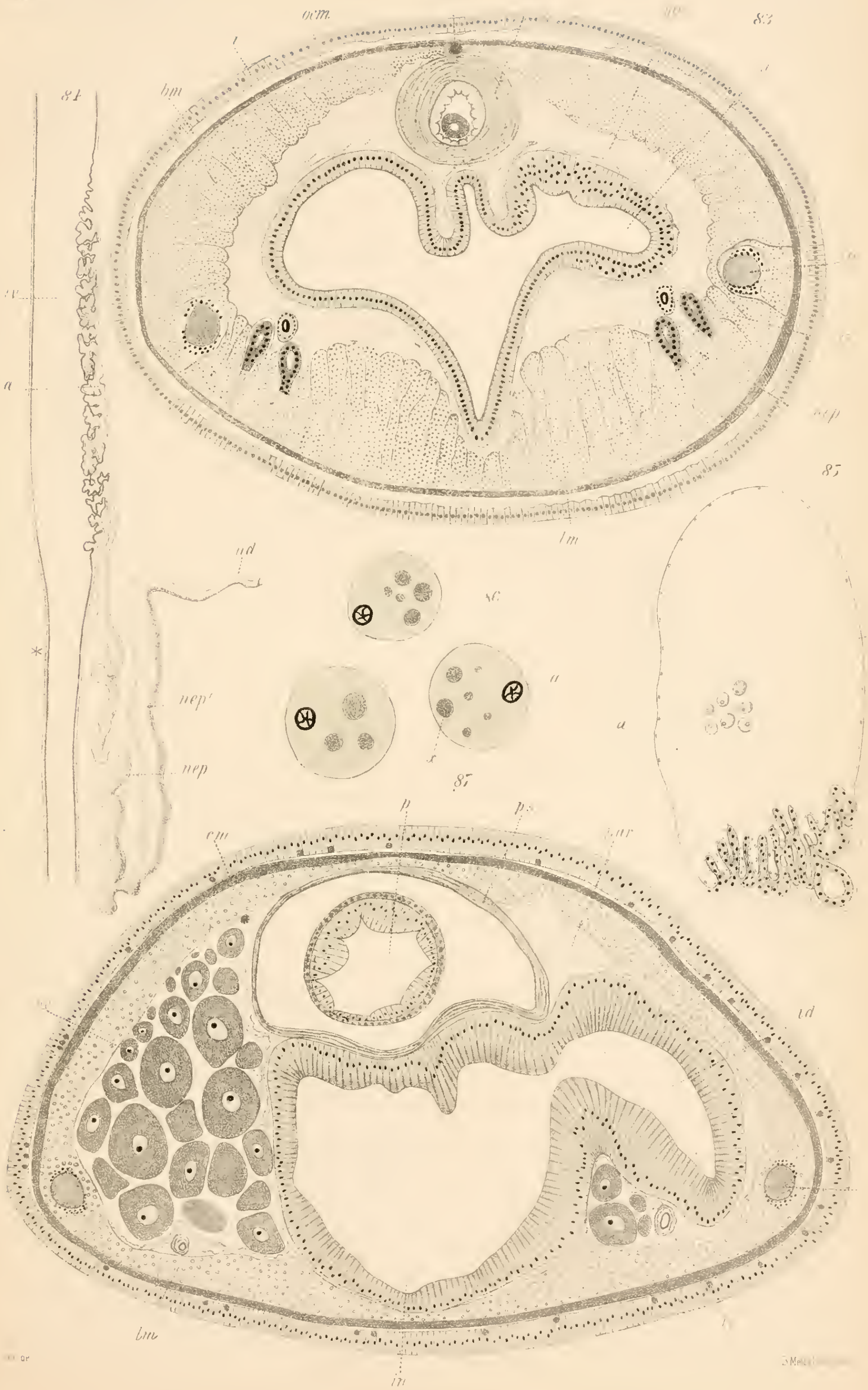
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PLATE 15.

Figs. 88 and 89, *Carinoma mutabilis* Griffin.
Figs. 90 to 92, *Carinella sexlineata* Griffin.

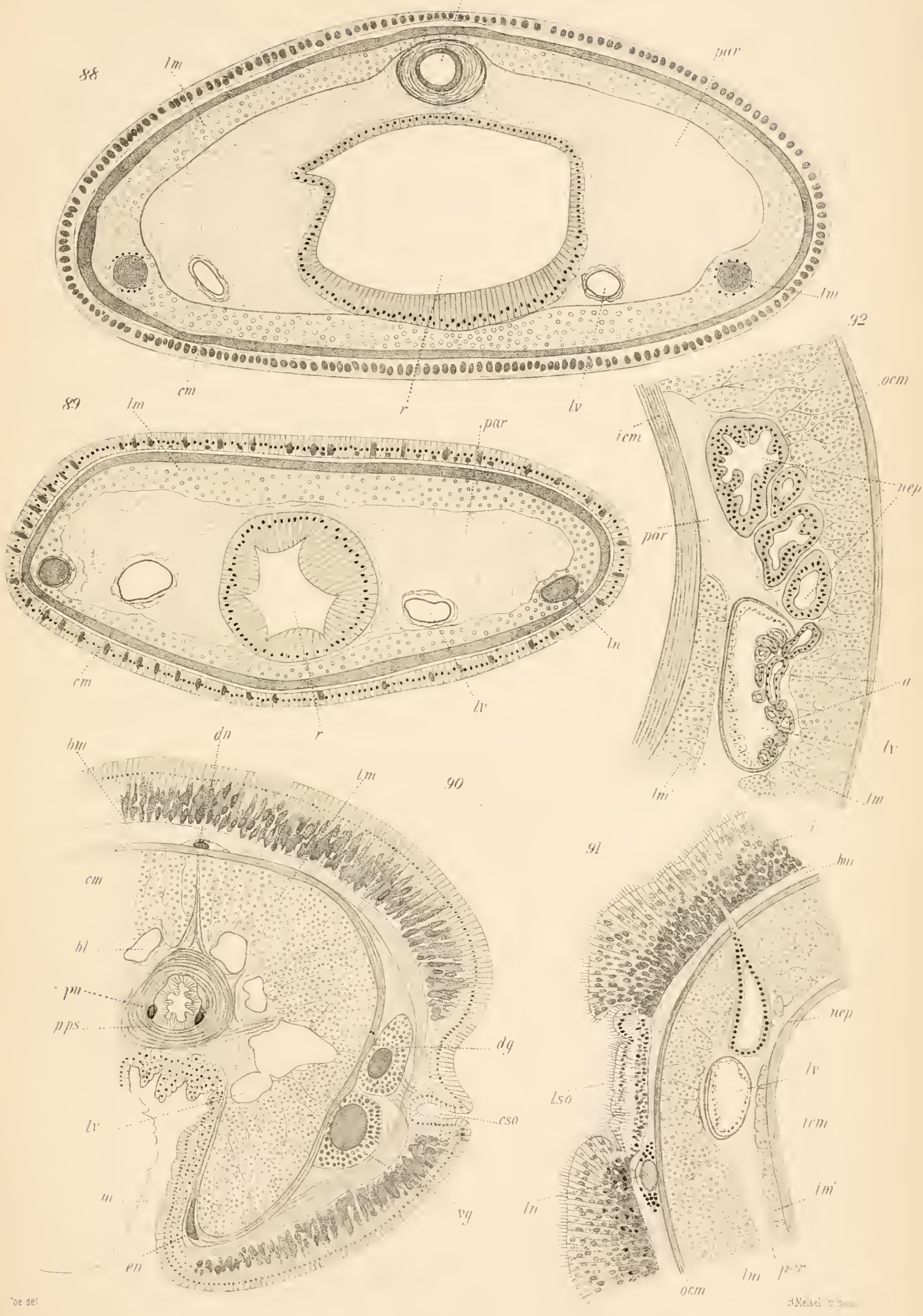
Fig. 88. *Carinoma mutabilis.* Transverse section well toward posterior end of rectum, showing the large amount of parenchyma (*par*) separating the rectum (*r*) from the body walls. The proboscis sheath is cut very near its posterior extremity. × 70.

Fig. 89. *Carinoma mutabilis.* Transverse section very near posterior extremity, and behind posterior end of proboscis sheath, showing the small size of the rectum (*r*) and the thick mass of parenchyma (*par*) which occupies the greater portion of the space enclosed by the body walls. × 70.

Fig. 90. *Carinella sexlineata.* Portion of transverse section through the mouth region, showing the position of the ventral and dorsal ganglia (*vg*, *dg*,) and the relation of the cerebral sense organ (*cso*) to the latter. The dorso-median (*dn*), esophageal (*en*) and proboscidial (*pn*) nerves are conspicuous. The proboscis is here attached to the sheath (*p*, *ps*), and is surrounded by several large blood spaces (*bl*, *lv*). A thick fibrous basement membrane (*bm*) lies between the integument and the brain and nerves. × 40.

Fig. 91. *Carinella sexlineata.* Portion of transverse section of body in region of lateral sense organ, showing relation of sense organ (*lso*) to adjacent integument and to the lateral nerve. The longitudinal musculature is here divided into an outer and an inner portion (*lm*, *lm'*) by the parenchyma (*par*). The main nephridial canal (*nep*) is cut within a few sections of the efferent nephridial duct. × 40.

Fig. 92. *Carinella sexlineata.* Portion of transverse section in esophageal region, and some distance anterior to section shown in Fig. 91, showing the relation of the fine tubules of the nephridial gland (*a*) to the lumen of the lateral blood vessel, and the large nephridial canals lying dorsal thereto. The longitudinal musculature is divided into an outer and an inner portion (*lm*, *lm'*) by the parenchyma (*par*) as shown in Fig. 91. × 80.



Coe del. Meisel, Bost.

PLATE 16.

Fig. 93. *Amphiporus similis* Coe. Sketch of head and anterior portion of body, showing arrangement of the ocelli and position of brain. × 50.

Fig. 94. *A. similis.* Central stylet and basis. × 400.

Fig. 95. *Paranemertes peregrina* Coe. Head and anterior portion of body, showing arrangement of ocelli and position of brain. × 15.

Fig. 96. *P. peregrina.* Central stylet and basis. The spiral markings are made rather too prominent. × 420.

Fig. 97. *Amphiporus flavescens* Coe. Head and anterior portion of body, showing arrangement of ocelli, position of brain, and the anterior diverticula of the intestinal caecum (*ic*). × 50.

Fig. 98. *A. flavescens.* Central stylet and basis. × 320.

Fig. 99. *Amphiporus imparispinosus* Griffin. Head and anterior portion of body, showing arrangement of ocelli and position of brain. × 40.

Fig. 100. *A. imparispinosus.* Central stylet and basis. × 200.

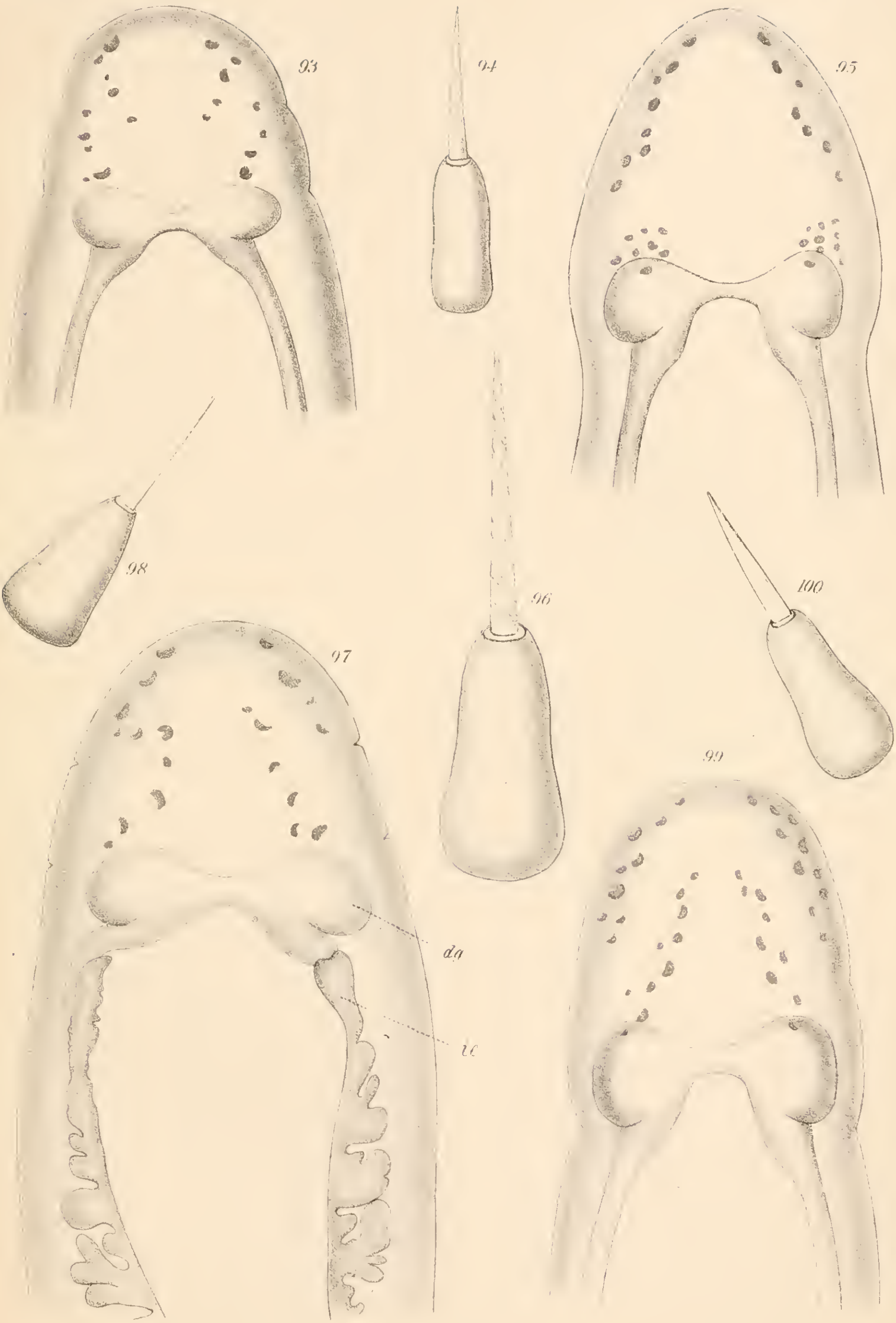

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PLATE 17.

Fig. 101. *Amphiporus formidabilis* Griffin. Head and anterior portion of body, showing arrangement of the 200 ocelli and position of brain. × 20.

Fig. 102. *A. formidabilis.* Stylet apparatus of proboscis, with central stylet and basis and 12 pouches of acessory stylets. × 70.

Fig. 103. *Paranemertes peregrina* Coe. Side view of head, showing position of ocelli and boundary between dark color of dorsal surface and lighter color of ventral side of body. × 8.

Fig. 104. *Tetrastemma albidum* Coe. Head and anterior portion of body, showing position of ocelli (with adjacent pigment granules), brain, and cerebral sense organs (*cso*). × 32.

Fig. 105. *T. albidum.* Central stylet and basis. × 440.

Fig. 106. *Drepanophorus ritteri* Coe. Sketch of head when much compressed after preservation, showing arrangement of ocelli. Those of the marginal groups, however, are in life visible only from the ventral surface, and are arranged more nearly in a single row than in the contracted specimen here shown. × 15. Cf. Pl. **24**, figs. 179–181.

Fig. 107. *Emplectonema purpuratum* Coe. Stylet apparatus of proboscis, showing central stylet and basis and the two pouches of accessory stylets, all with longitudinal flutings. × 84.

Fig. 108. *E. purpuratum.* Accessory stylet, showing conspicuous longitudinal flutings. × 300.

Fig. 109. *Amphiporus pacificus* Coe. Outline of body after preservation. × $1\frac{1}{2}$.

Fig. 110. *A. pacificus.* Head and anterior portion of body, showing arrangement of ocelli. × 14.

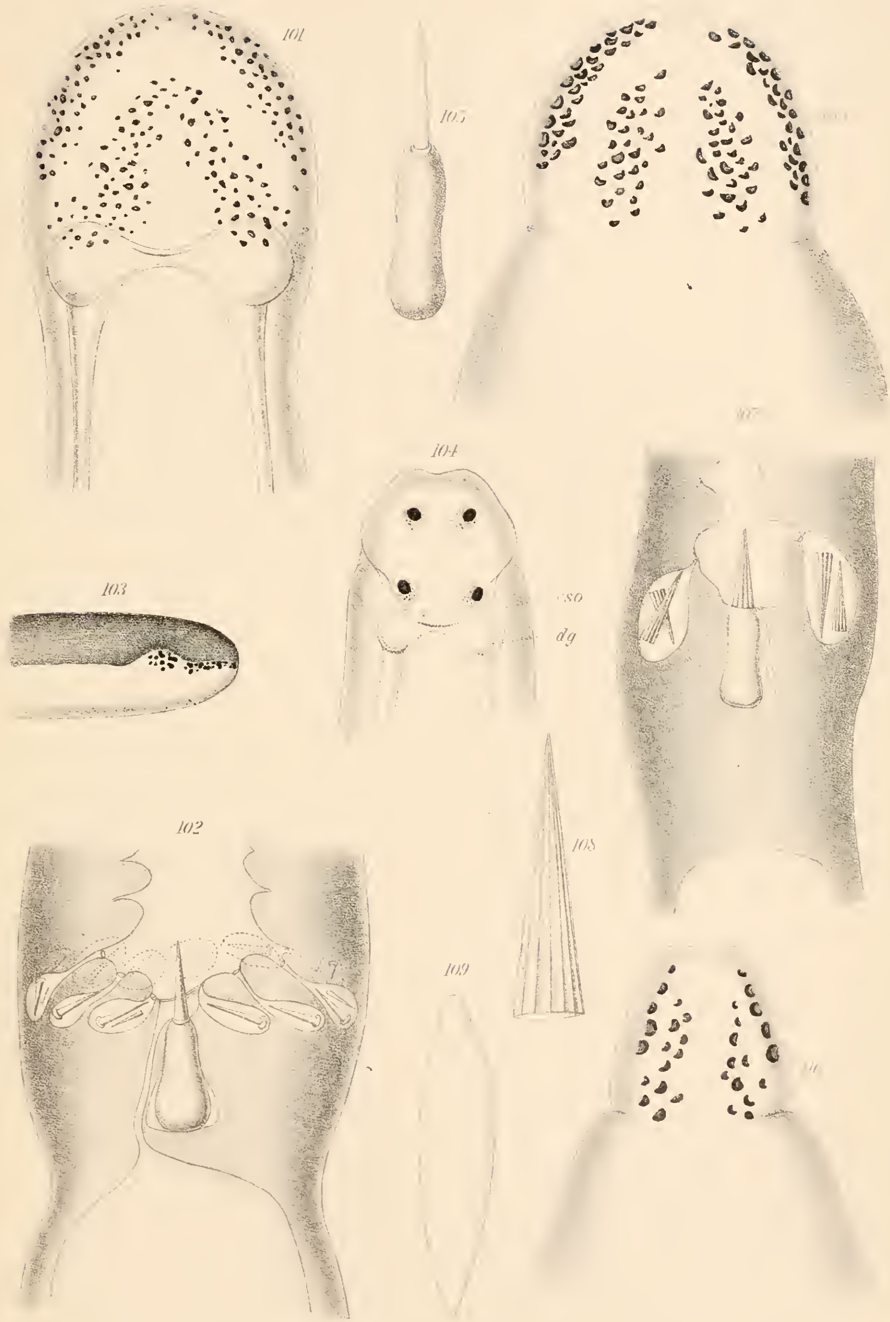
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PLATE 18.

Figs. 111 to 115, *Tetrastemma nigrifrons* Coe.
Figs. 116 to 118, *Amphiporus bimaculatus* Coe.

Fig. 111. *Tetrastemma nigrifrons.* Dorsal surface of head and anterior portion of body, showing the two pairs of cephalic grooves, of which the posterior pair forms a distinct collar. The black cephalic marking and the dark color of body back of head are represented by dark shading. × 20.

Fig. 112. *T. nigrifrons.* Ventral side of head, showing position of cephalic grooves and extent of dark coloring on body. × 20.

Fig. 113. *T. nigrifrons.* Dorsal side of head of pale variety, showing position of cephalic grooves, ocelli and cephalic marking. × 35.

Fig. 114. *T. nigrifrons.* Central stylet and basis, showing dark posterior portion of latter. × 200.

Fig. 115. *T. nigrifrons.* Stylet apparatus. Basis with dark posterior portion. × 50.

Fig. 116. *Amphiporus bimaculatus.* Ventral side of head. The extent of the fluted cephalic grooves is shown on ventral surface, and is represented in outline on dorsal surface. × 12.

Fig. 117. *A. bimaculatus.* Dorsal side of head and anterior portion of body, showing extent of fluted cephalic grooves, position of cephalic markings, and arrangement of ocelli. A pair of inconspicuous oblique grooves occurs back of head. × 12.

Fig. 118. *A. bimaculatus.* Central stylet and basis. × 240.

(Figs. 111, 112, 116, 117 after drawings by J. F. Abbott. Others by W. R. Coe.)

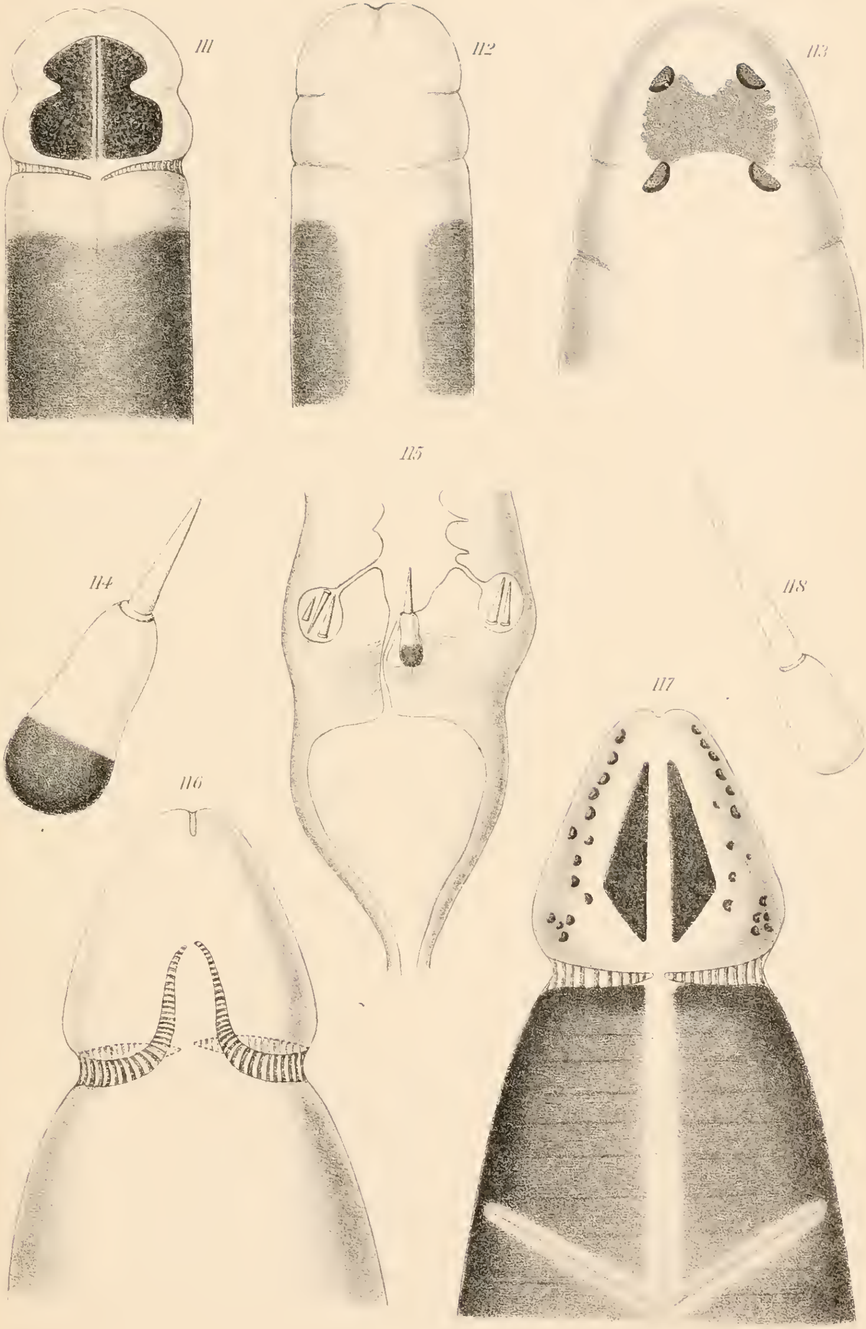
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PLATE 19.

Amphiporus gelatinosus Coe.

Fig. 119. Transverse section of head in brain region, showing the relatively small size of brain, rhynchodaeum (*rh*), esophagus, and blood vessels as compared with the enormous mass of parenchyma (*par*) between these organs and the body walls. The brain is cut through the ventral commissure. The ocelli lie in or directly beneath the muscular layers of the body walls, and are therefore widely removed from the brain. × 40.

Fig. 120. Portion of transverse section of body near middle of esophageal region, showing the relatively small size of proboscis sheath, stomach, and other organs as compared with the great mass of parenchyma which occupies the major portion of the space enclosed by the body walls. On the right side of the stomach is seen the small intestinal caecum (*ic*), and above the lateral nerve the branches of the nephridial system (*nep*) with the efferent duct (*nd*) opening to the exterior above the lateral nerve — a condition rare among the Hoplonemertea. × 31.

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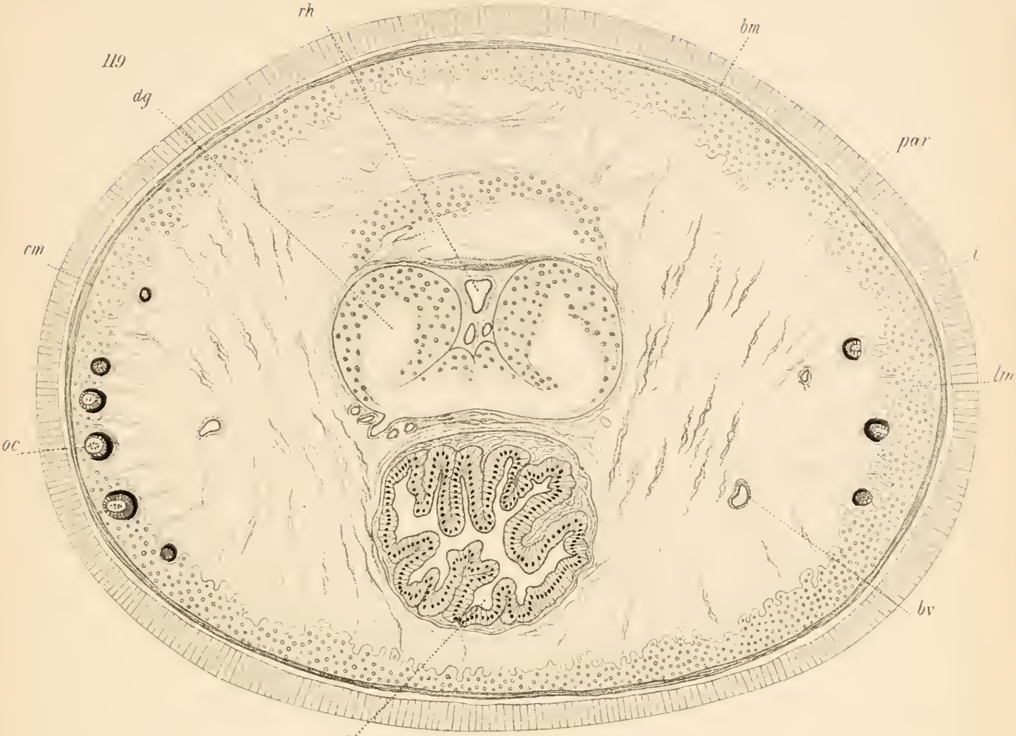

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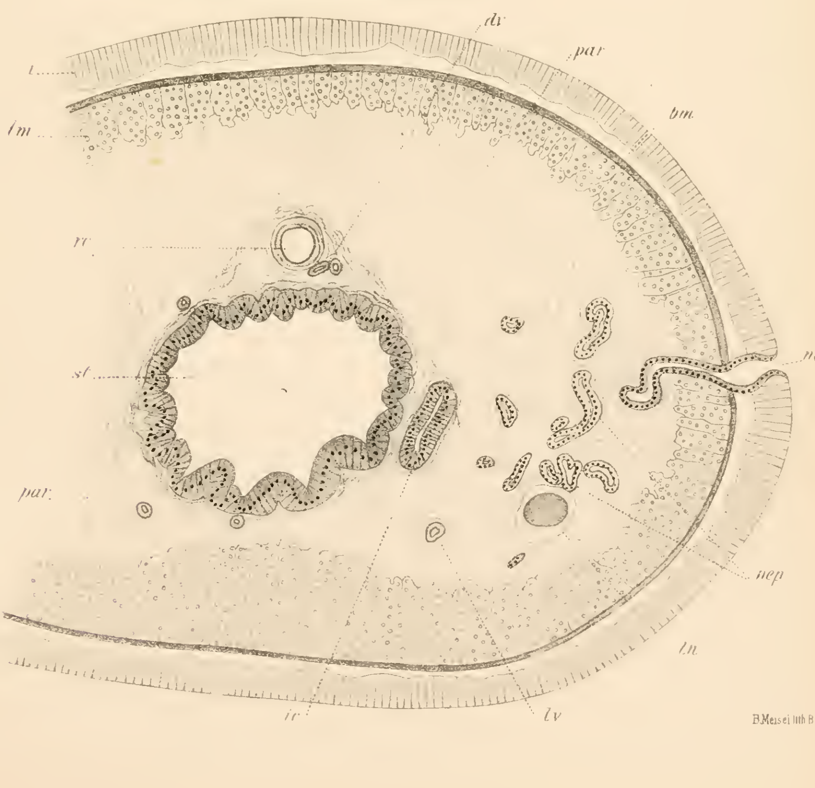

PLATE 20.

Fig. 121. *Amphiporus occidentalis* Coe.
Figs. 122 to 127. *Amphiporus gelatinosus* Coe.
Fig. 128. *Drepanophorus ritteri* Coe.

Fig. 121. *Amphiporus occidentalis.* Reconstruction of anterior portion of alimentary canal, showing rhynchodaeal opening (*ro*), esophagus (*e*), esophageal caecum (*ec*) with appendix (*app*) thereto, cardiac caecum (*cac*), stomach (*st*), pylorus (*pyl*), opening into intestine (*i*), at point marked x, and intestinal caecum (*ic*), with its paired anterior branches (*ic'*). The asterisk (*) denotes position of most anterior sexual glands.

Fig. 122. *Amphiporus gelatinosus.* Portion of transverse section of body in intestinal region, showing the great amount of parenchyma which surrounds the intestine (*in*) and its lateral diverticula (*id*). The very small proboscis sheath with the dorsal vessel beneath it is widely separated from the dorsal body walls by the thick mass of parenchyma. The sexual glands (*ov*), each containing a single ovum, lie free in the parenchyma beneath the body walls, which are remarkably thin as compared with the size of the body. × 20.

Fig. 123. *A. gelatinosus.* Portion of musculature of body wall in brain region, showing the great numbers of submuscular glands (*smg*) lying between the bundles of longitudinal muscles (*lm*) and opening directly to the exterior of the body. × 120.

Fig. 124. *A. gelatinosus.* Various forms of connective tissue elements which constitute the cellular structure of the body parenchyma. × 1000.

Figs. 125–127. *A. gelatinosus.* Three stages in the development of the single ovum which matures in each gonad; *n*, nucleus (germinal vesicle) of ovum; *yn*, yolk nucleus; *fo*, follicle which surrounds ovum and later forms the efferent duct (*fo'*); *a*, attachment of ovum to follicle. Figs. 125, 126, × 250; Fig. 127, × 160.

Fig. 128. *Drepanophorus ritteri.* Portion of integument and underlying basement membrane and circular musculature, showing the peculiar deep staining basal glands (*bg*) which occupy the deepest layer of the integument. × 300.

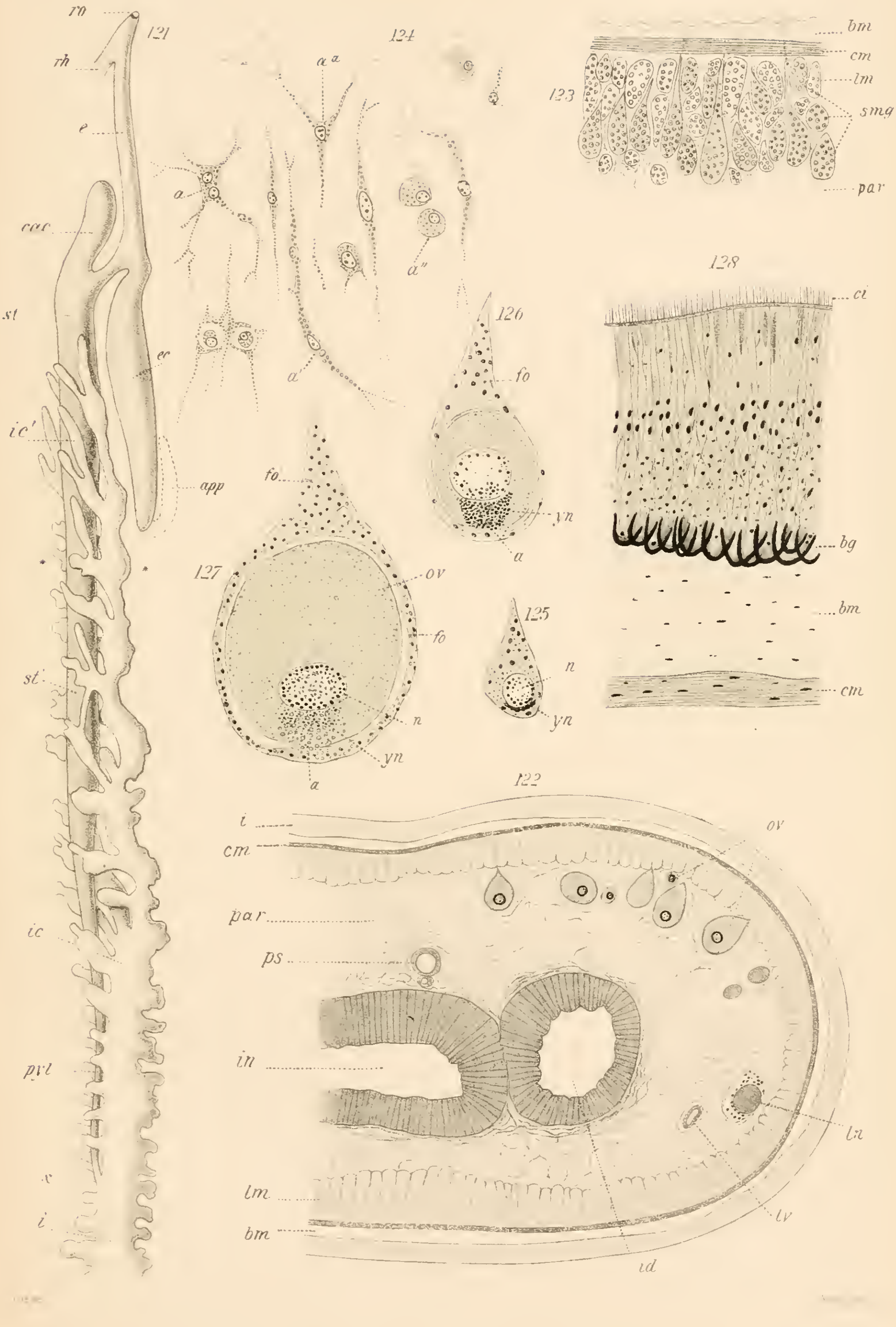
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PLATE 21.

Amphiporus punctatulus Coe.

Fig. 129. Outline of head from dorsal surface, showing arrangement of ocelli, and position of brain and cerebral sense organs. × 18.

Fig. 130. Outline of head in state of contraction, showing arrangement of ocelli. × 18.

Fig. 131. Sagittal section of head, showing the highly developed cephalic glands, position of ocelli, nephridia, muscular layers, brain, and posterior end of cerebral sense organ. × 32.

Fig. 132. Transverse section of body near posterior extremity, showing the layer of inner circular muscles (*icm*) surrounding the rectum (*r*) and the dorso-ventral muscles (*dom*). The lateral nerves (*ln*) are situated in the midst of the body parenchyma. × 78.

Fig. 133. Transverse section of body near anus and behind lateral nerves, showing the thick layer of inner circular muscles surrounding the posterior end of rectum. × 78.

Fig. 134. Portion of transverse section of body near anus, showing inner circular muscular layer (*icm*) surrounding posterior end of rectum (*r*) and radially arranged fibers extending peripherally. × 230.

Fig. 135. Outline of central stylet and basis in four individuals. × 58.

Fig. 136. Central stylet and basis, showing central core of stylet. × 135.

Fig. 137. A single accessory stylet, showing central core. × 240.

Fig. 138. Central stylet and basis in two individuals. × 80.

Fig. 139. Five accessory stylets with outline of central core. × 105.

Fig. 140. Accessory stylets, outline only. × 105.

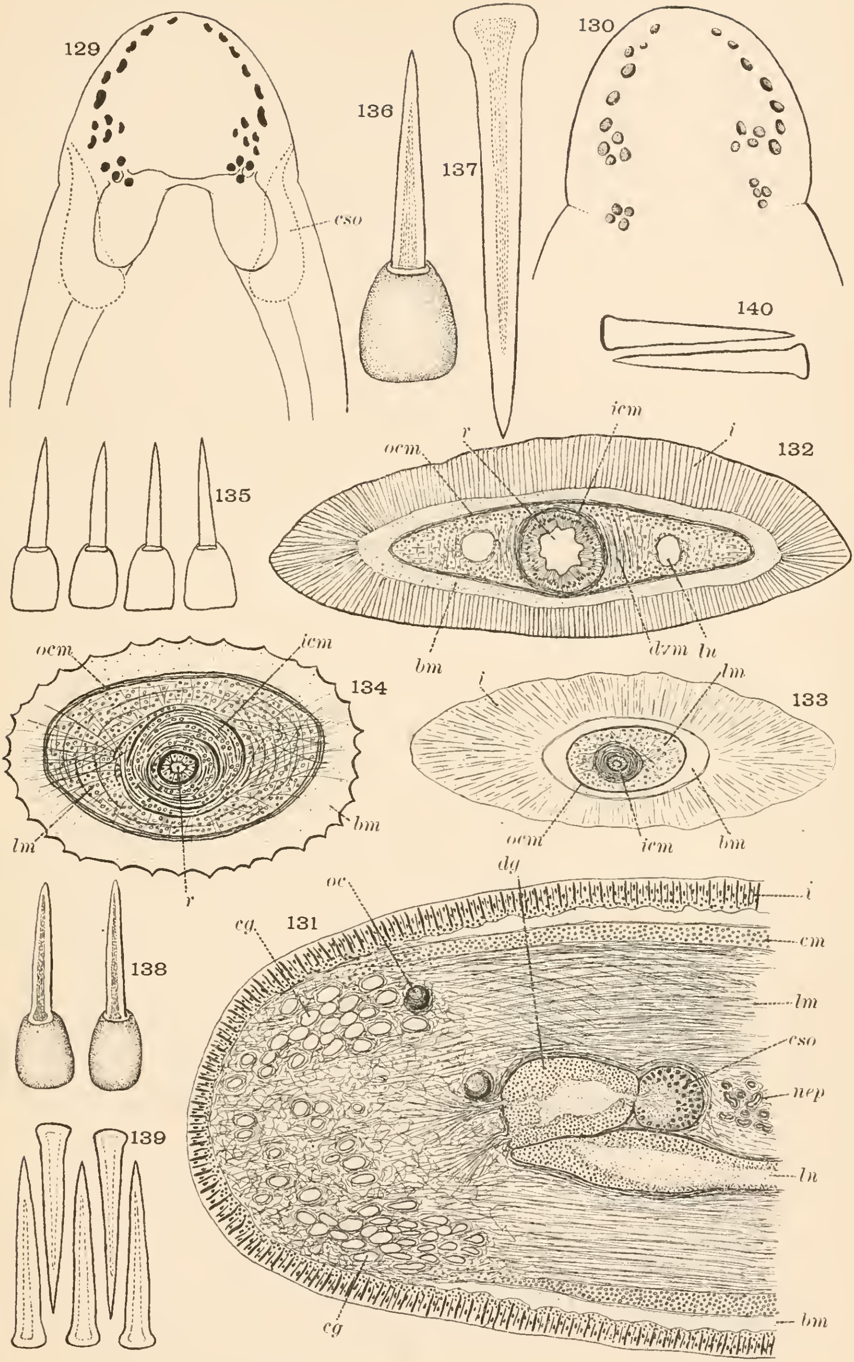
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PLATE 22.

Fig. 141. *Zygonemertes virescens* (Verrill). Outline of anterior portion of body, showing arrangement of ocelli, which extend in front of brain and along lateral nerves. × 28.

Fig. 142. *Z. virescens.* Central stylet and basis in large individual. × 220.

Fig. 143. *Z. virescens.* Accessory stylets. × 220.

Fig. 144. *Z. virescens.* Central stylet and basis in very small, pinkish individual. × 200.

Fig. 145. *Tetrastemma albidum* Coe. Outline of anterior portion of body, showing arrangement of ocelli in life. × 50.

Fig. 146. *T. albidum.* Outline of anterior portion of body, showing arrangement of ocelli after preservation. × 50.

Figs. 147, 148. *T. albidum.* Central stylets and bases in four individuals. × 400.

Fig. 149. *T. albidum.* Central stylet and basis. × 220.

Fig. 150. *Tetrastemma aberrans* Coe. Outline of head, showing position of fragmented ocelli. × 50.

Fig. 151. *Tetrastemma caecum* Coe. Outline of body with extruded proboscis showing, in stipple, large size of mature ova. × 20.

Fig. 152. *Amphiporus similis* Coe. Outline of anterior portion of body, showing arrangement of ocelli. × 50.

Fig. 153. *A. similis.* Outline of central stylets and bases in two individuals. × 320.

Fig. 154. *Amphiporus bimaculatus* Coe. Anterior portion of body, showing position of ocelli and extent of cephalic and body markings × 26.

Fig. 155. *A. bimaculatus.* Outline of central stylet and basis. × 180.

Fig. 156. *A. bimaculatus.* Basis of central stylet. × 180.

Fig. 157. *Amphiporus nebulosus* Coe. Outline of anterior portion of body showing arrangement of ocelli. × 10.

Fig. 158. *A. nebulosus.* Central stylet and basis. × 150.

Fig. 159. *Emplectonema purpuratum* Coe. Central stylet and basis. × 133.

Fig. 160. *E. purpuratum.* Central stylet, showing longitudinal flutings. × 312.

Fig. 161. *Amphiporus leptacanthus* Coe. Outline of basis of central stylet. × 312.

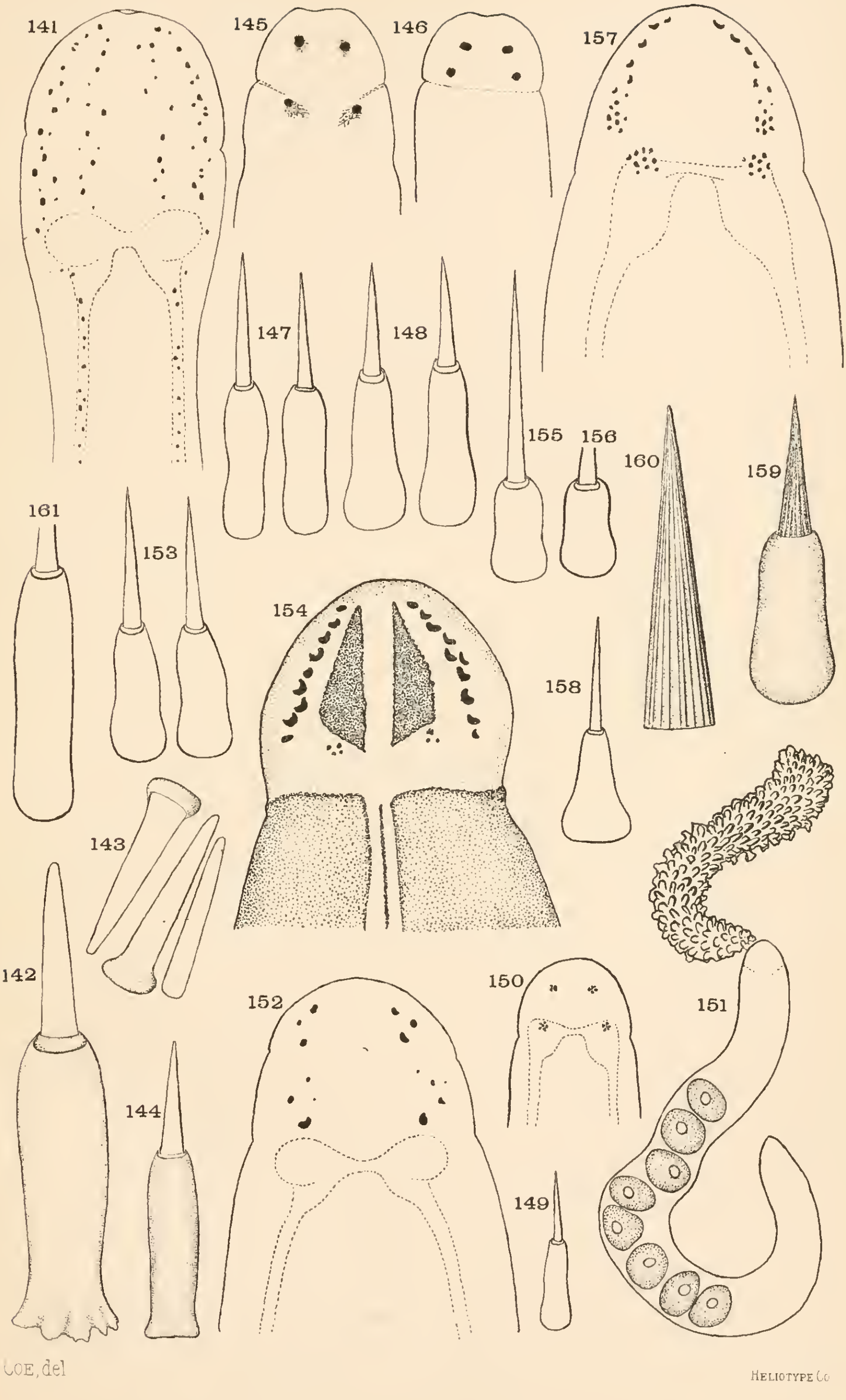

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PLATE 23.

Figs. 162–171. *Amphiporus flavescens* Coe.
Figs. 172–176. *Amphiporus californicus* Coe.
Figs. 177, 178. *Paranemertes carnea* Coe.

Fig. 162. *A. flavescens.* Outline of anterior portion of body, showing arrangement of ocelli, position of brain and (in stipple) anterior extent of intestinal caeca. × 40.

Fig. 163. *A. flavescens.* Similar outline of smaller individual with fewer ocelli. × 50.

Fig. 164. *A. flavescens.* Various corpuscles from proboscis sheath fluid. × 375.

Fig. 165. *A. flavescens.* Central stylet and basis. × 360.

Figs. 166, 167. *A. flavescens.* Outlines of central stylets and bases and accessory stylets. × 240.

Fig. 168. *A. flavescens.* Outline of central stylet and basis after strong compression and consequent flattening of basis. × 220.

Fig. 169. *A. flavescens.* Accessory stylets. × 220.

Fig. 170. *A. flavescens.* Central stylet and basis. × 220.

Fig. 171. *A. flavescens.* Central stylet and basis, somewhat flattened. × 220.

Fig. 172. *A. californicus.* Outline of anterior portion of body, showing arrangement of ocelli. × 25.

Figs. 173, 174. *A. californicus.* Central stylets and bases in two individuals. × 300.

Fig. 175. *A. californicus.* Outline of stylet apparatus of proboscis. Basis broader than in most individuals. × 200.

Fig. 176. *A. californicus.* Central stylet and basis. × 400.

Fig. 177. *P. carnea.* Outline of anterior portion of body, showing arrangement of ocelli. × 8.

Fig. 178. *P. carnea.* Central stylet and basis. × 175.

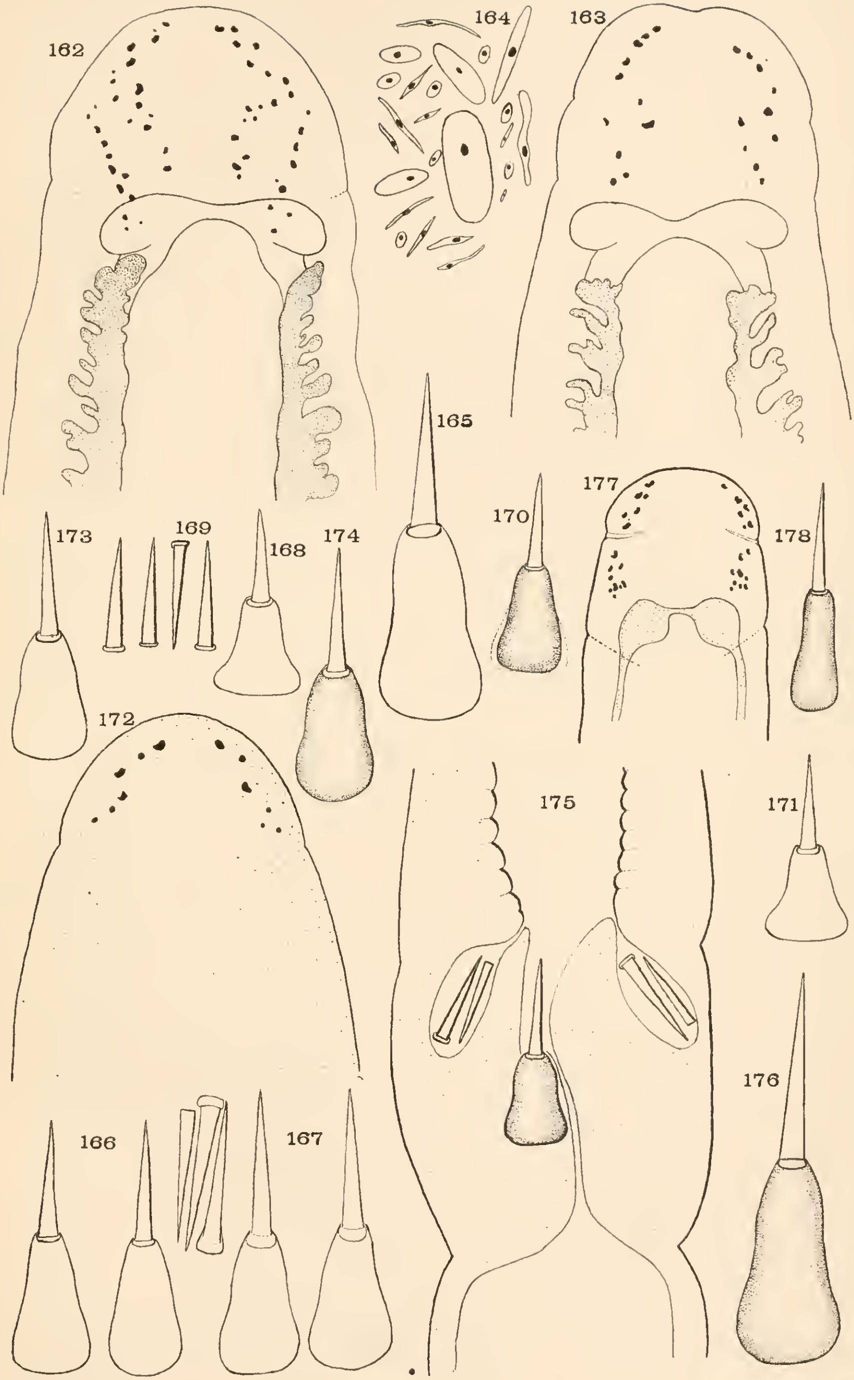

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PLATE 24.

Fig. 179. *Drepanophorus ritteri* Coe. Outline of anterior portion of body, showing cephalic grooves and arrangement of ocelli as seen from dorsal surface. A large individual. × 13.

Fig. 180. *D. ritteri.* Outline of ventral side of head, showing rhynchodaeal opening, mouth, and arrangement of ocelli as seen from the ventral surface. × 13.

Fig. 181. *D. ritteri.* Outline of anterior portion of body, showing ocelli of both dorsal (*oc*) and ventral (*oc'*) surfaces, position of brain, cerebral sense organs and cephalic nerves. × 10.

Fig. 182. *Zygonemertes albida* Coe. Outline of anterior portion of body, showing arrangement of ocelli. × 10.

Fig. 183. *Z. albida.* Outline of central stylet and basis. × 350.

Fig. 184. *Amphiporus fulvus* Coe. Outline of anterior portion of body, showing arrangement of ocelli. × 40.

Figs. 185, 186. *A. fulvus.* Outline of central stylets and bases in three individuals. × 225.

Fig. 187. *Emplectonema bürgeri* Coe. Outline of anterior portion of body, showing arrangement of ocelli. × 12.

Fig. 188. *E. bürgeri.* Outline of central stylets and bases in two individuals. × 170.

Fig. 189. *Micrura pardalis* Coe. Outline of anterior portion of body, showing arrangement of ocelli. × 32.

Fig. 190. *Paranemertes pallida* Coe. Outline of anterior portion of body, showing arrangement of ocelli. × 9.

Fig. 191. *P. pallida.* Outline of central stylet and basis. × 220.

Fig. 192. *Paranemertes peregrina* Coe. Central stylet and basis, showing groovings of stylet. × 375.

Fig. 193. *Amphiporus macracanthus* Coe. Outline of central stylet and basis. × 62.

Fig. 194. *Amphiporus punctatulus* Coe. Outline of stylet apparatus. × 25.

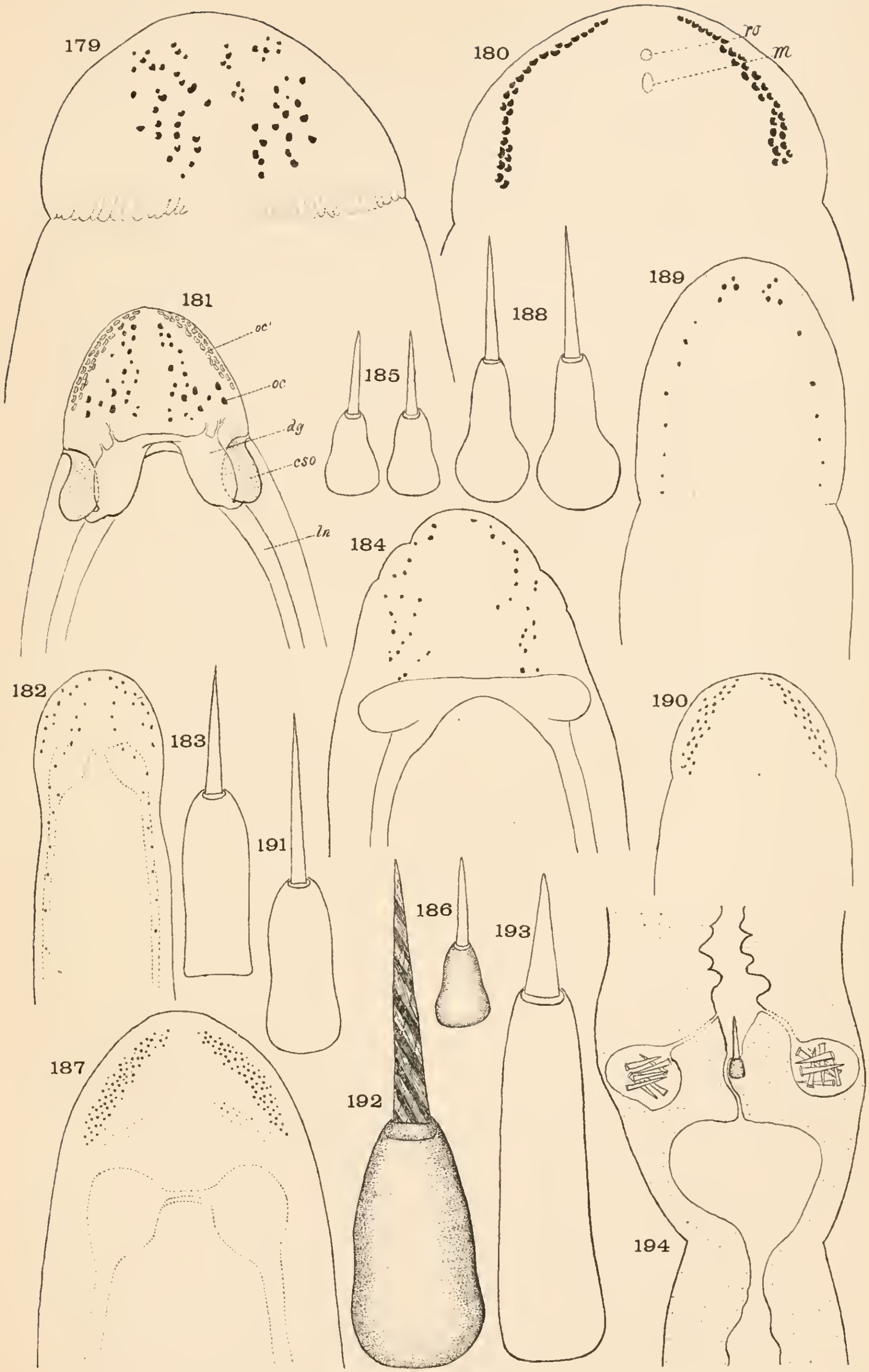

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PLATE 25.

Fig. 195. *Amphiporus imparispinosus* Griffin. Outline of anterior portion of body of large individual having comparatively small ocelli. × 30.

Fig. 196. *A. imparispinosus.* A similar view of a small specimen. × 40.

Fig. 197. *A. imparispinosus.* A similar view of a large individual with numerous large ocelli. × 25.

Fig. 198. *Paranemertes peregrina* Coe. Outline of anterior end of body, showing arrangement of ocelli. × 12.

Fig. 199. *P. peregrina.* A similar view of specimen with fewer but larger ocelli. × 20.

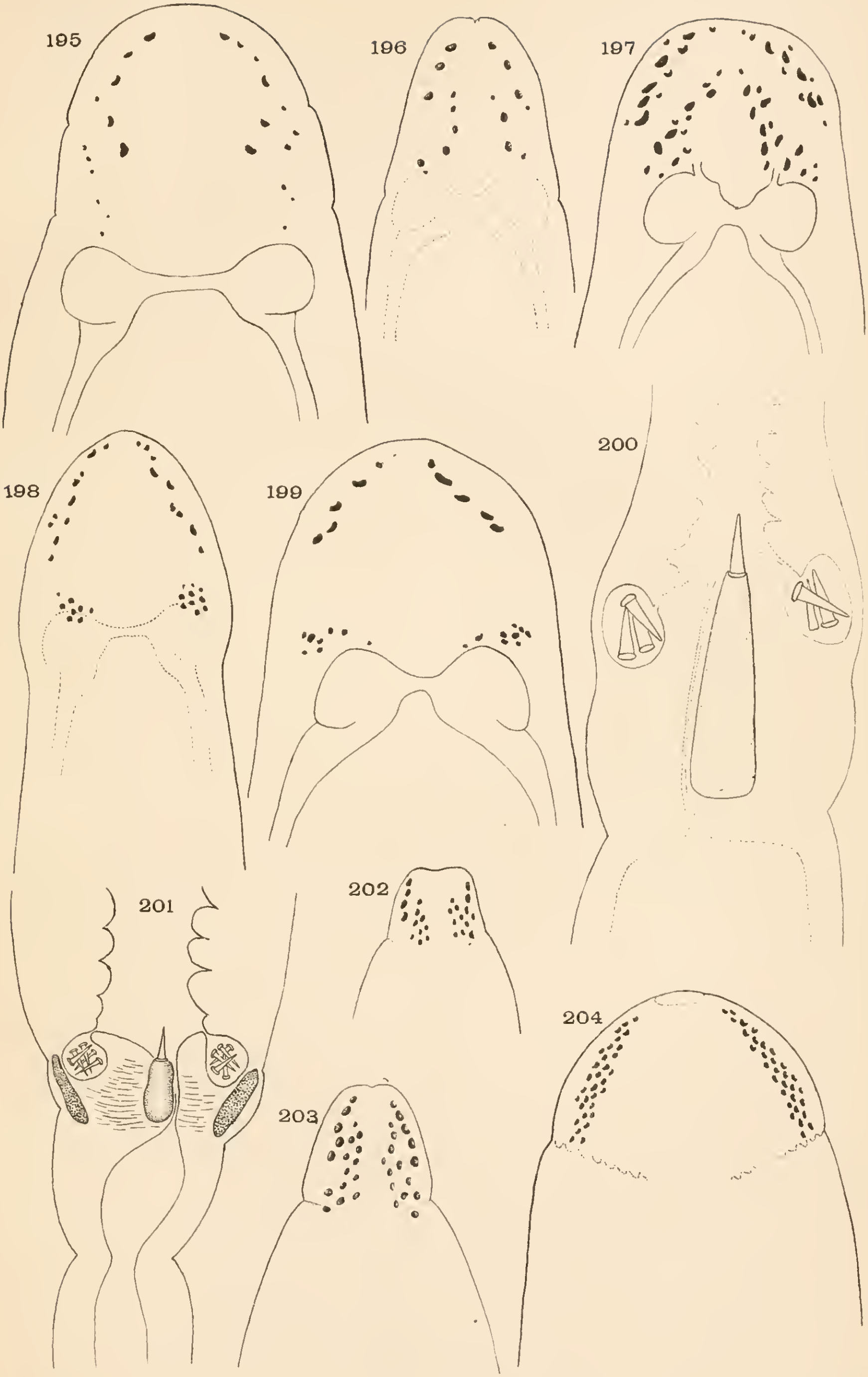
Fig. 200. *Amphiporus macracanthus* Coe. Outline of stylet apparatus of proboscis. × 34.

Fig. 201. *Amphiporus tigrinus* Coe. Outline of stylet apparatus of proboscis. × 50.

Fig. 202. *Amphiporus pacificus* Coe. Outline of anterior portion of body, showing arrangement of ocelli. × 10.

Fig. 203. A large individual of the same species, showing arrangement of ocelli. × 10.

Fig. 204. *Amphiporus gelatinosus* Coe. Outline of anterior portion of body, showing arrangement of ocelli. × 10.



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Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows: —

E. EHLERS. The Annelids of the "Blake."
C. HARTLAUB. The Comatulæ of the "Blake," with 15 Plates.
E. LUDWIG. The Genus Pentacrinus.
A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
" On Arachnactis.
R. T. HILL. On the Geology of the Windward Islands.
W. McM. WOODWORTH. On the Bololo or Palolo of Fiji and Samoa.
AGASSIZ and WHITMAN. Pelagic Fishes. Part II., with 14 Plates.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross, Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows: —

A. AGASSIZ. The Pelagic Fauna.
" The Panamic Deep-Sea Fauna.
K. BRANDT. The Sagittæ.
" The Thalassicolæ.
he Siphonophores.
he Eyes of the Deep-Sea .
The Mollusks.
H. J. HANSEN. The Cirripeds.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
C. A. KOFOID. Solenogaster.
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H. LUDWIG. The Starfishes.
J. P. McMURRICH. The Actinarians.
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JOHN MURRAY. The Bottom Specimens.
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THEO. STUDER. The Alcyonarians.
M. P. A. TRAUSTEDT. The Salpidæ and Doliolidæ.
H. B. WARD. The Sipunculids.
W. McM. WOODWORTH. The Nemerteans.
" The Annelids.

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OF THE

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AT HARVARD COLLEGE.

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The BULLETIN and MEMOIRS are devoted to the publication of original work by the Professors and Assistants of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

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Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commision Steamer "Albatross," from August, 1899 to March, 1900. Commander Jefferson F. Moser, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

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